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THE GLASS INDUSTRY.

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THE DEVELOPMENT OF AMERICAN INDUSTRIES SINCE COLUMBUS. XVII.

ALONG the eastern base of the Rocky Mountains there is found a hard, dark mineral known as obsidian, or volcanic glass. It is a variety of feldspar. In the chemical sense, it is a true glass, since it is a silicate of at least two metals, aluminium and potassium. Physically, it half deserves the name. Though too dark to be transparent, it is at least translucent; and in its luster, hardness, and glassy fracture it is quite comparable to the products of industrial glass-houses. Travelers in New Mexico are offered bits of this volcanic glass by the Pueblo Indians who congregate at Wallace and other dining stations along the railroad.

The manufacture of glass in America seems, then, to have been first set up by Nature, and may easily claim priority to all our other industries. It was one of the native products used in the early receptions given to the invading white man; but lest the spirit of the hospitality be misunderstood, it should be added that it was served in the form of swiftly flying arrowheads. When Columbus came to this country the glass industry was limited to a rude fashioning of the material supplied by Nature. It had been melted in fires burned out long centuries before.

In the Europe of 1492, the operations of glass-making were still very crude and inadequate. It was a rare thing to have glazed windows, even in castle and palace. For many years the luxury was limited to the churches, and there it was an article of decoration rather than of utility. In domestic service, the supply of

glassware was equally limited. Yet it was only a hundred and sixteen years after the discovery of America that the first glass works were established in the colonies. It was a modest venture in an industrial way, but one to which much importance is attached, since it was the starting point in that interesting history which it is the purpose of the present paper to outline; and still more, because it was the first industry started by Europeans on American soil. It thus heads a list which is to-day certainly as long as human needs and almost as long as human desires. It is a list which has been nearly three hundred years in the making.

This was in the year 1608. The pioneer glass-house was a part of the activities at Jamestown. The spirit of the London Company was distinctly commercial. It had gold and silver in mind as the ultimate goal, but, with a prudence characteristic of British enterprise, it had also an eye to nearer and smaller profits. The plan of colonial manufacture was meant to serve this end. On the second voyage of Captain Newport, eight Poles and Germans were sent over for the express purpose of making glass, pitch, tar, and soap-ashes. The glass-house was out in the woods, about a mile from Jamestown. It was a crude affair, but it seems to have been the center of considerable activity, for when the ship returned to England in the following year, "a trial of glass" was among her cargo. The glass was presumably exported in the form of common black bottles, for the state of the art in those days, and the limited time, would scarcely have allowed the evolution of anything more difficult of manufacture.

The progress of the glass industry in America has been far from constant. It has suffered severe and violent fluctuations, amounting almost to annihilation. Several times it has needed to be born again. But the sum total of these successes and vicissitudes has been the establishment of an industry which, while it is the oldest, is also at the present time one of the most promising and most highly developed of all our industries. To understand its rise and progress, one must be familiar with the elements which go to make it up.

Four things are needed to make glass: crude materials; refractory substances for crucibles and furnaces; suitable fuel, and intelligent labor. To make glass commercially, a fifth factor is all important, and that is an accessible market.

The history of the industry has consisted in the various possible interchanges between these elements. They are far from permanent. The causes which led to the early establishment of the Jamestown glass-house were good and valid for the year 1608, although a somewhat pessimistic writer declared the energy misdirected, but they would not hold in the year 1893. The compelling force which gathers our present glass-houses to such

centers as Pittsburg and southern New Jersey may shift during the course of a decade or so, and bring about a migration of the industry, similar to the migrations which so many of our industries have undergone. It requires a nice technical and commercial judgment to strike a balance which shall equally satisfy all these requirements. So it has come about that in certain branches of the industry, and notably in the manufacture of plate glass, the record until quite recently is an almost uninterrupted record of financial disaster.

A word, then, in regard to these elements, beginning with the first, the crude materials.

In many respects the most important ingredient is silica, since every true glass is a silicate of two or more metals. Sands and sandstones are its commercial representative. They are found the world over, but not of equal purity. Much of this material is quite unfit for the glass-maker's use, on account of the iron and other impurities which it contains. Here we reach at once a determining cause in the habitat of the industry. But the discrimination does not end with a chemical examination of the sand rock. It concerns itself quite as strenuously with the physical structure of the material. As it is needful that all the ingredients of the batch shall be in a state of fine powder, the condition of the silica supplied by Nature is a matter of no small importance. If Nature has already done the grinding, and sandstone and quartz ledge have relapsed into the form of a sand bank, so much the better for our purpose; or, if the choice be between two sand rocks of unequal hardness and tenacity, the softer and more easily reducible rock will be the available one. In this respect America is exceedingly well off. Her sands are among the finest in the world. Both English and French writers on glass declare them to be superior to their own supplies. They are as abundant, too, as they are excellent. The best deposits in New England are those of Berkshire County, Mass. In Pennsylvania the sands of Juniata and Fayette Counties are extensively mined. Other notable localities are in Hancock County, W. Va., Fox River, Ill., Crystal City, Mo., and southern New Jersey. New deposits in various parts of the country are constantly being announced. The importance of this wealth of sand to the glass-maker will readily be appreciated when it is remembered that the average glass contains from sixty to seventy per cent of silica. It is indeed the very foundation of the material.

The next most important constituent is the alkali, which is generally a carbonate of either sodium or potassium. At the present time the sulphate of soda, or salt-cake, is also frequently employed. The function of the alkali is to furnish one of the metals of the double silicate. Where the carbonate is used, sodium is

now chosen—the "soda" of the markets, as it happens to be the cheaper. Our forefathers used potash. As none of these substances are furnished directly by Nature, the supply is subject to more rapid and more extreme fluctuations than in the case of silica. Before the Napoleonic wars, and indeed until within comparatively recent times, the chief source of the alkaline carbonates was the ashes of wood and sea-weed. Whole forests were burned, and vast piles of sea-weed were annually collected and reduced to ashes to gain the alkalies. To-day at many a country hearth the wood ashes are carefully put aside for the annual soap-making. Our earlier glass-makers were thus dependent upon the coastman or forester for their supply of alkali, and it can readily be seen that this dependence was a large determining factor in the development of the industry. The poor quality and the uncertain supply were an inconvenience particularly felt in France, where war so often cut off the foreign commerce. To protect French industries from these international hazards, as well as to secure a better supply at all times, the French Government offered a prize for the invention of a process by which soda could be made directly from common salt. The Leblanc soda process was the result. It was published in 1792. By means of the new process any nation which possessed salt springs or brines—and there are few without them—was enabled to make its own soda. The process came into use but slowly, though its effect has been very far-reaching, since it transferred the soda manufacture from the wilderness to the laboratory. In the development of glass-making in America these improvements were quite without influence until within the last half century or so. At the present time we are still largely dependent upon England for our supply of alkali, but there is a promising increase in the home manufacture. The large production of salt in Michigan and New York yields an assured supply of the crude material within comparatively short distances of the glass-making centers, while recently invented processes have greatly improved upon the method of Leblanc.

The third constituent of ordinary glass, limestone, is so abundant and so free from impurity that it is scarcely a determining factor in the development of the industry. One stone is almost as good as another. There is a tendency toward the increased use of lime in modern glass-making, but it is a tendency which may be indulged at very slight expense.

In the finer grades of tableware and decorative products lead takes the place of lime as the second base in the silicate, but with this material, again, America is well supplied. The immense deposits of lead ore in the Mississippi Valley, and the large output of the metal from the silver smelters of the West, make the supply of the oxide quite up to the demand.

But a locality which furnished silica, alkali, and lime would still be badly off as regards the needs of glass-making if it were out of reach of adequate supplies of substances refractory enough when fashioned into crucibles to permit the fusion of the mixture. For this purpose fire clay is the material *par excellence*, since it withstands both the chemical action of the molten glass and the disintegrating effect of the intense heat of the furnace. It is an essential to glass-making. Bulk for bulk, however, much less fire clay is needed than crude material for the batch, so that it is less needful that the fire clay shall be a local product. It can be brought to the batch more economically than the batch can be taken to it. It does not happen, therefore, in the history of the glass industry, that the mere presence of suitable clay ever determines the location of works. At the present time much of the clay used in both England and America comes from Germany. It is significant, in looking over the columns of our trade journals, that the advertisements are for the most part of the imported rather than the native article. There are, however, large deposits of excellent clay in northeastern New Jersey, in western Pennsylvania, in Missouri, in Ohio, and in other parts of the country, which must eventually be utilized. The American clay is, if anything, purer than the foreign, but it is less dense, and will probably require somewhat different treatment from the German. The attempt to substitute it for the imported in the earlier days, before the requirements of the pot clay were so well known and our own deposits had been so well exploited, led to financial disaster, and even to the suspension of a large works at Boston, where the experiment proved absolutely fatal. Our knowledge of refractory materials is less scientific than of any of the other materials used in glass-making. In consequence we are the more dependent upon rule-of-thumb methods in working them, and pay the more dearly for the experience when we venture any innovation.

The third element involved, fuel, is of all the most important, both as regards quality and cost. In America it has been the dominant element, and largely determined the location of our glass-houses and the measure of their success. The choice lies between four varieties—wood, coal, petroleum, and natural gas. In the earlier days a fifth fuel is found on the list, North Carolina rosin, but it can hardly be said to figure in the present production. In England coal does not seem to have been used as a fuel to any extent until the beginning of the seventeenth century. About 1623 Sir Robert Mansell obtained a patent for a "method of making glass with sea coal, pit coal, or any other fuel not being timber or wood." The patent was probably for some particular method, as the simple use of coal was well known, even in the preceding century, though by no means common. The early Virginia glass

works were operated entirely with wood. The same practice prevailed in Europe, and for many years wood was preferred to coal. This made it necessary to establish glass-houses near the forest districts, for in the absence of railroads and of steam navigation it was impracticable to carry so bulky a fuel for any great distance. With the substitution of coal a new condition was introduced, and the question of fuel became for the time of less moment than the supply of crude materials. These could only be obtained in certain localities, while the fossil fuel was available in many. In our own day, and within the last half dozen years, another and much greater disturbance of the industrial equilibrium has been brought about by the displacement of coal by natural gas. It is no exaggeration to say that, as far as quantity and the perfection of the processes of manipulation are concerned, the development of the glass industry has been greater, since the introduction of natural gas than in all previous time. The immense advantage of the fluid fuel over the solid, both in economy of operation and superiority of product, has made the geography of the glass industry and of natural gas nearly identical. One might almost use a geological map of the United States for a chart of the glass-making districts. Wherever the Trenton limestone and the upper coal measures are near the outcrop, one may reasonably expect to find glass-houses scattered over the surface.

It does not follow, of course, that glass-making at the present day is limited entirely to the natural gas country. There are occasional glass-houses in various localities, and there are districts so favorably located in other respects that they can overcome the disadvantages of the solid fuel and still rank as recognized centers of the industry. Such a center is found in the large bottle-making establishments in southern New Jersey. But these works are generally quite old, and already had expensive plants in operation before the utilization of natural gas.

The character of the fuel has thus given rise to three distinct eras in the industry—that of wood, of coal, and of gas. The use of petroleum has been too limited and for too secondary purposes to mark a distinct chapter.

The fourth essential element is labor. While it is, in a technical sense, the most important element of all, it has had much less influence than the material factors in deciding the history of the industry. Since its emancipation from serfdom, labor has displayed a portability which has made it available in any quarter of the globe. A large degree of dexterity, if not of intelligence, is needed in the glass-worker; but if one is to judge from the mixed nationality of our American representatives of the craft, he does not belong to any country, and is ready to go wherever he is wanted. It is easier to bring him to the work than to take

the work to him. Once located, he is fairly permanent, and his dexterity is soon reproduced in the band of apprentices who gather around him.

With our present increasing output, the question of a market is no less important than the technical operations. The product is so fragile and so bulky that the market must needs be fairly accessible. Difficulties of transportation wrecked a number of the earlier enterprises. An observer of the first attempts at glass-making in Virginia reported that the industry would have done very well had there been any market for its wares.

These are the five elements which in the kaleidoscope of industrial progress have given us the series of pictures constituting the history of the glass industry. These pictures are the more intelligible when one has studied their elements separately.

The Jamestown venture in 1608 was evidently undertaken because of the abundance of timber. This gave the necessary supply of potash as well as of fuel. The early colonists in America suffered indeed from an embarrassment of riches in the way of forests. They needed no arbor-days. As a consequence, any enterprise which cleared the land for farming, and did it at a profit, commended itself to their thrift. So in the colonial records of the seventeenth century we find not infrequent mention of existing or projected glass works. The early Virginia enterprise was followed, in 1621, by a more extensive attempt. Subscriptions were opened in London for funds to build a second glass-house—the first having fallen into decay—to be devoted to the manufacture of beads for the Indian trade. Italian workmen, probably educated in the famous factories of Murano, were sent over to the colony to take part in the new enterprise. It was, however, brought to a tragic end by the Indian massacres of the following year, when the glass-house was destroyed. The natives seem to have been for the time quite blind to the allurements of glass beads, or they may have thought that they were paying too high a price for them. With this double failure glass-making in Virginia entirely ceased, and was not revived until many years after.

Meanwhile, Massachusetts was starting her first glass works. These were at Salem, and were built in 1638. In New England the town has ever been an active agent in all affairs concerning the public good. It took a lively and possibly at times a troublesome interest in these early manufactures. The establishment of glass works at Salem was held to be an event of public importance, and the town voted the projectors several acres of land, which passed into record as the Glass-House Fields. In 1641 it showed its further interest in the enterprise by granting a loan of thirty pounds. The works continued in operation for some time, turn-

ing out for the most part simply bottles and the rougher sorts of domestic wares. They finally stopped operations in 1670, "for lack of capital."

In New York, Jan Smeedes was making hollow ware in glass somewhat before the year 1664, and his enterprise gave the name of the "Glass-Makers' Street" to the lane in which he worked. He does not seem to have had any successor, however, for after his death the industry disappears from the records until the following century.

Well-meaning efforts were also made to establish the industry in Pennsylvania in the closing years of the century, but they do not seem to have been successful. In a letter, written in 1683, Penn alludes to a glass-house then existing in Philadelphia, and speaks hopefully of its prospects; but these were never realized. Yet there seems to have been a good market for window glass at least, if we are to credit the following doggerel, written by Holme in 1689:

> "The window glass is often here
> Exceeding scarce and very dear,
> So that some in this way do take
> Isinglass windows for to make."

These are the only known records of glass-making during the seventeenth century. None of the attempts became permanent industries. The advantages of cheap and abundant fuel and of easily obtainable alkali were more than offset by the corresponding disadvantages found in all new communities. In some of the colonies there was no accessible market. But the greatest obstacle was the pressure of more remunerative occupations upon the attention of the glass-workers. Land was everywhere abundant and could be had almost for the asking. The temptation to pass from the artisan class to the ranks of the gentry was a strong one in the minds of European workers. It was an unusual opportunity, and in both this and the following century the privations of early agriculture were willingly endured for a time by those who had originally come to the colonies for the purpose of service or the trades, in order that they might ultimately enjoy the satisfaction of being landholders. This "desertion," as it was called by the wage-paying classes, led to the abandonment of many promising manufacturing enterprises. America stood then, perhaps more than now, for personal liberty and individualism. Men seem to have been less willing to sell themselves into industrial slavery, and more anxious to remain their own masters.

The eighteenth century witnessed an extensive revival of the glass industry, and gave birth to some of the most important establishments of the present day. This activity was, however, crowded into the latter part of the century.

Massachusetts took the lead. About 1750 works were erected by German artisans at the village of Germantown in Braintree. They were intended for the manufacture of bottles. After a short run they were destroyed by fire, and were never rebuilt. Two years later the General Court attempted to encourage the industry by granting Isaac C. Winslow the sole privilege of making glass; but he seems not to have profited in his monopoly, for in 1787 the same exclusive privilege was granted to a Boston company. The monopoly covered fifteen years, and had attached to it a penalty of five hundred pounds for each infringement. By this time there was a sufficient home market to warrant somewhat extensive operations. Public sentiment was overwhelmingly in favor of American products. The company devoted itself to the manufacture of crown glass, and was one of the first makers of window glass in America. It started out rather badly by erecting a large and ill-adapted factory at the foot of Essex Street. This had afterward to be taken down and another structure put up in its place. Then came difficulties in obtaining workmen, so that the new industry did not get under way until the fall of 1792. In the following year the company was fortunate in securing the services of a skillful German glass-blower named Lindt, and under his management the enterprise was wonderfully successful. The Boston window glass was reported to be equal to the best imported glass, and possibly even superior. The shares of the company sold at a good price, and the industry enjoyed, or suffered, something very similar to a modern boom. By the end of the century the annual output of window glass amounted to seventy-six thousand dollars. But the confidence born of success finally brought the company into difficulty. They extended their operations in several directions, and made the dangerous experiment of substituting native fire clay for the imported. They were also embarrassed by a lack of suitable fuel. These difficulties, combined with subsequent bad management, finally led to failure, and the works were shut down.

In New York, glass-making was again undertaken in 1754. The factory was located in what is now Brooklyn; the venture being made by a Dutch gentleman of the name of Bamper. But the enterprise was of short life. A little later, Albany seems to have been the center of the glass industry. A Flemish family by the name of De Neufville were the chief spirits in these enterprises. It is uncertain how many glass-houses they established, but one at least seems to have been in operation in 1786, and to have had a very hard time of it. In 1788 Leonard de Neufville and his partners appealed to the State for aid in behalf of the Dowesborough glass-house. Their patience must have been severely taxed, however, for it was not until 1793 that their petition

was granted. The Legislature voted them a loan of three thousand pounds for eight years, three years without interest and five years at five per cent. Three years later the enterprise was moved to Hamilton, a manufacturing town which had just been laid out some ten miles to the west of Albany. The plant consisted of two glass-houses with three large furnaces. Thirteen glass-blowers were employed, and turned out twenty thousand feet of window glass a month—nearly half an acre—besides a fair output of bottles and flint glass. The fuel was gathered from the pine forests of the neighborhood. The methods employed seem to have been much the same as elsewhere, except that they were carried out with much system, and that kelp, the ashes of sea-weed, were substituted for the purified potash. The product found a ready market, and for some time the industry was in a most flourishing condition. But, with the cutting down of the surrounding forests, fuel became more and more scarce. The final abandonment of the enterprise in 1815 is said to have been due to this cause.

But in none of the colonies were the conditions for glass-making, and particularly of bottles and the coarser kinds of hollow ware, so entirely favorable as in southern New Jersey. Extensive pine forests covered thousands of acres, while sand of sufficient purity existed in large quantities and had only to be carted a few feet to the glass-house. Qualities which make the region most unpromising for other purposes have devoted it to the use of the glass-maker. For more than a hundred years it has been the home of the bottle trade. About the middle of the last century a glass-house was established in Salem County. It was known as Wistar's, and employed a number of German glass-blowers. Other glass-houses were established throughout the county, illustrating even at that early day the now well-recognized gregariousness of manufactures. Many of them were subsequently abandoned. There was a general exodus of German workmen to the spot, which has since been called Glassborough. Here in 1775 they established a bottle factory which is still in existence, and is the oldest continuous glass-house in America, as well as the largest of our present bottle factories. It was, however, many years before the manufacture of other grades of glass was attempted. The conditions best adapt the region to the production of green glass. Though window glass has since been successfully made, the competition with other districts farther west is very unequal; so long as the locality continues to be a glass producer, it will probably always maintain its original place in the glass industry.

There is a certain picturesqueness about the development of the industry in Pennsylvania. In Penn's time, and indeed for many years after, it was simply a succession of failures, but these failures are hardly less interesting than the successes elsewhere.

The most extensive attempt was that made by the Baron Steigel in 1762. He built the village of Manheim, eleven miles from Lancaster, and erected iron furnaces and glass works in the neighborhood. Operations were conducted upon quite a grand scale, and the glass produced was of excellent quality, but the enterprise was far from successful. The baron was too dramatic. His home was a veritable castle, and from its battlements the discharge of cannon announced the return of the lord of the manor, and summoned his retainers from furnace and factory to do honor to the occasion. This is thought to have somewhat interfered with the processes of glass-making. The war cut off his income from across seas and forced the abandonment of the works. The iron establishment passed into the hands of the Coleman family, and is still in operation.

West of the Alleghanies the industry was slower in finding a footing, but the conditions there made its establishment a matter of destiny. Mr. Albert Gallatin and his associates established a flourishing window-glass factory at New Geneva in Fayette County, somewhere about the year 1797. Various dates have been assigned for this undertaking, one published statement placing it as early as 1785, but the most reliable evidence appears to be in favor of the later date. The abundance of good glass sand and the wealth of timber were the attracting forces. The glass-house was forty feet square and contained one eight-pot furnace. The enterprise was reasonably successful and continued for thirty or forty years. But more significant was the opening of a glass-house in Pittsburg somewhat earlier than this, since the city has now become the center of the industry in America. There is a tradition that this early factory was established in 1795, and was located on the west side of the Monongahela, at what is now called Glass-house Ripple. It was devoted extensively to the production of window glass, and is reported to have been about the same size as the New Geneva plant. Two years later, in 1797, General James O'Hara and Major Isaac Craig established more extensive works, whose date and history are quite authentic. We believe that these were the first works in America to use coal in the manufacture of glass. As the supply of fuel was right at hand and practically inexhaustible, they escaped a source of danger which constantly menaced those establishments which depended upon wood. The works were intended for the production of window glass, but, like many of the plants in those days, also turned out some bottles. A memorandum found among General O'Hara's papers suggests that for a time at least the outgo made more impression upon him than the income, for it reads, "To-day we made the first bottle, at the cost of thirty thousand dollars." Many difficulties had to be met and overcome before the works proved successful. They were

subsequently enlarged and improved, and glass-making became one of the recognized industries of Pittsburg. A glass-house has ever since been in continuous operation upon the very site of this early factory. It can not be said, however, that glass-making was really an assured success in Pittsburg until as late as 1830.

The other colonies were also more or less active in glass production. Attracted by the cheapness of fuel and labor, Mr. Robert Hewes, of Boston, set up a glass-house at Temple, N. H., in 1780. Like most industrial pioneers, he had rather a hard time of it, and, after making some window glass and hollow ware, abandoned the enterprise in the following year. A reference in Washington's diary shows that glass was made in New Haven, Conn., in 1789, and a glass-house is known to have been in operation at about the same time in Hartford. In Maryland the industry obtained quite a firm footing. The Legislature encouraged it by loans, and the General Government in 1789, at the instance of Mr. Carroll, gave American glass works the protection of a ten-per-cent customs duty. The first factory was located at Tuscarora Creek, near Frederickstown, and was known as the Etna Glass Works. Like so many other glass factories, it was under German management, the owner being Mr. John F. Amelung. The works were started in 1775 and were moved to Baltimore in 1788. Both sheet glass and bottles were produced, the output enjoying a high reputation for superior quality. But, in spite of its technical success, the venture was a financial failure, and had finally to be abandoned. The "Baltimore Glass Works," established in 1790, were more successful, and, I believe, are still in operation.

[*To be continued.*]

By the death of Lord Tennyson, says Nature, "not only does England lose one of her noblest sons, but the world loses the poet who, above all others who have ever lived, combined the love and knowledge of Nature with the unceasing study of the causes of things and of Nature's laws. When from this point of view we compare him with his forerunners, Dante is the only one it is needful to name; but although Dante's knowledge was abreast of his time, he lacked the fullness of Tennyson, for the reason that in his day science was restricted within narrow limits. It is right and fitting that the highest poetry should be associated with the highest knowledge, and in the study of science, as Tennyson has shown us, we have one of the necessary bases of the fullest poetry—a poetry which appeals at the same time to the deepest emotions and the highest and broadest intellects of mankind. Tennyson, in short, has shown that science and poetry, so far from being antagonistic, must forever advance from side to side." Tennyson was a Fellow of the Royal Society, and that body was represented at his funeral by its president and officers. Prof. Lockyer speaks very highly of Tennyson's interest in astronomy and acquaintance with it.

MAN IN NATURE.

By M. PAUL TOPINARD.

MAN is an animal, by the same title with other animals, without any more rights than those conferred upon him by virtue of the law of the strongest, by his physical organization, his physiological attributes, and his success in the struggle for existence. His body is of the same substance, is composed of the same tissues, and possesses the same organs. His forms are simple variants, produced by the same force that urges other beings to differentiation. Like every animal, he participates in the everlasting round of being born, reproducing, and dying. He was such when Galen dissected the ape to study it, and he has continued the same, resembling the ape in some respects and differing from it in others, subject to the same wants, the same physical experiences, the same instinctive impulses, the same inner feeling urging him to take everything to himself. In consideration of the highly developed properties of his cerebral organ, of his judgment, which permits him to see things exactly as they are, of his memory, which enables him to store up observations and draw inductions of the whole from them, of his routine-breaking initiative, and of his ideal conceptions, he may by a turn of mind regard himself as forming a separate kingdom in the Cosmos. But, in his body he is and always will be an animal—a vertebrate, a mammal, a monodelph, a Primate. None of the characteristics of these groups is wanting in him; eminently none of those of the Primates. He possesses peculiar characteristics which give him a special place of favor among them; but he begins by having their general characters.

"Then," you will tell us, "you place man by the side of the monkeys, of those beings which are often so abject. Could you not find a nobler animal?" That is prejudice, judgment by appearances. The monkeys are not disinherited beings, but the contrary. Some of the ungulates—the deers and the horses—have reached a high grade in the scale of the mammals: we esteem them because of the perfect adaptation of all their parts to an ideal of existence; their forms are elegant, their paces are graceful and rapid; they render us service while contributing to our pleasures; they are the last efflorescence of a branch which has been growing and blooming since the Eocene epoch. Some of the carnivores, like the cats, are likewise objects of our admiration for the complete harmony of their whole organisms to their peculiar modes of life; they have power, nobility, and freedom. But neither of these possess what the humble monkeys have—a cerebral type, predicted among them all from its origin, and already

developed in the ugliest among them. The brain of the horse, nearest by virtue of its less rudimentary anterior lobe to that of the Primates, is rude, notwithstanding its well-formed convolutions, in comparison with that of the simians in general. Even the skull of the monkeys has something human, and reflects the interior cerebral organ. The brain has been evolved in all the branches of the tree of the mammalia, and at the end of some branches is elaborate in its convolutions, sometimes surpassing that of man in their richness. But in only one branch, that of the monkeys, does that exist from the beginning which gives the brain a special value, and causes them eventually to excel, whether the number of convolutions be equal or unequal.

We are amused with the monkeys, without remarking how marvelously they too are organized for their peculiar mode of life. We see them sporting, grimacing, swinging from one branch to another, and performing the most incredible feats of real acrobats. But we do not reflect that these habits, these necessities of their existence, are precisely what has given rise to the organ to which man owes most, after the brain—the hand. That hand, which by a curious aberration had in some of the marsupials abandoned the anterior for the posterior extremity, still occupies that extremity in the lemurians. In the monkeys it returns to take possession of its natural place of election, there to perfect itself gradually and to result in the incomparable apparatus which has caused Franklin to define man as "the maker of instruments."

The brain and its accompanying type of skull, the hand and its annexes the nails, are the characteristics which have produced the privileged situation of those animals which are correctly grouped together under the designation of the order of Primates. With some modifications in the proportions of the limbs to height and some accessory characteristics, their variants give place in them to divisions ranging from the lowest up to man. These divisions, whatever may be their relative value and their respective distances, are five: The lemurians—the monkeys of the New World, or the cebeans, from which the arctopithecans are sometimes separated; the monkeys of the Old World; tailed monkeys or pithecans; tailless or anthropoids; and man. A question which we had set before ourselves, and which had been much discussed in the Société d'Anthropologie, was whether the anthropoids of this list are nearer to the pithecan and cebean monkeys or to man. Shall we place in the same group monkeys and anthropoids or anthropoids and man? The question was then one of measuring in some way the interval between these anthropoids and man and comparing it with the subsequent intervals between the lower monkeys. From the result came the adoption of one or

other of the rival systems of classification, some separating man from the Primates as a special order, others isolating him among the Primates as a suborder or family, and others including man and the anthropoids together. We said we must draw up a general balance sheet. As the divergences sometimes pertain to what we consider only one aspect of the problem, it was necessary to regard all the aspects; and we have done this. We have given our conclusions respecting each characteristic, respecting each group of characteristics. Our present purpose is only to summarize the most affirmative of them, those that concern the brain and the skull, the adaptation of the body, and particularly of the lower limbs, to the bipedal attitude, and of the upper limbs to prehension.

In the general type of the brain we have only determined common characteristics in what concerns the profound structure.

The type of the convolutions appears to us rudimentary in the lower Primates; gradually developing, already characterized in the papion; absolutely established, according to Broca, in the gibbon; becoming more complicated in passing from the anthropoids to man, but without appreciable change to a characteristic which must not be neglected, the transformation of the third frontal convolution. Man alone presents the speech centre, a characteristic corresponding with the acquisition of the faculty of articulate language. The conclusion results that, even without regard to the richness of man's convolutions, there still exists between him and the anthropoids a difference—capital in its physiological consequences—which forbids any relation on this ground between them and him. As to the volume of the brain the conclusion is express. It is triple in man and leaves the anthropoids with the other monkeys.

The consequence of this increase of volume, general, but predominant in the anterior lobes, is the complete transformation of the skull. While it retains some of the characteristics peculiar to the Primates in general, which it had already assumed, it becomes what we know it in existing man, profoundly different in all its characteristics from the skull of the anthropoids, including the craniometrical characteristics. The face itself is transformed. All bends before the supremacy of the organ which, near or far, governs the whole human organism and separates it completely from the anthropoids.

The hand is the second fundamental characteristic of man, but a characteristic common to all the Primates, starting with the first ones and advancing continually toward perfection. With the monkeys, the forearm comes to the aid of the hand; with the anthropoids, the whole fore limb concurs in the function; in man it acquires its final degree of precision. Till then it was

simply a grasping apparatus related to tree life. With him its operations are associated with those of touch, sight, and the muscular sense, and it becomes the faithful executant of the orders of the brain. Is there anything more wonderful than the movement imperceptibly and gradually impressed by the fingers on the screw of the microscope in micrometrical operations? The hand, therefore, relates the anthropoid to man, but more in appearance than in reality, for in the anthropoid it still remains the brutal grasping apparatus of the monkeys.

The last characteristic is that of attitude. It is complex in the monkeys, similar in some respects to that of quadrupeds generally, but really special. Signs of the erection of the trunk are already manifested in some monkeys—as, for instance, the cynocephalus. This erection is emphasized in the anthropoids, but without reaching the upright position, and really permitting standing on the feet. With them the characteristics leading to that attitude bear on little else than the viscera and the vertebral column. They are inappreciable in the head, and are hardly more marked in the lower limbs, where the calves, thighs, and buttocks, characteristic of the effort necessary for keeping the upright position, are wanting.

Contrary to what has been said, the anthropoids are less qualified to hold themselves erect than the other monkeys. These can walk on the ground with extended sole; the anthropoids are less able to do so. The monkeys had in the lower as well as in the upper limbs a hand competent to act as a foot. This hand is improved in the anthropoids in the direction of its function of grasping, but to the detriment of its accessory function as a foot; in the lower limbs it is turned in in such a way that the palm can grasp a tree by the side, but can only painfully set itself on the ground upon its outer edge, and very likely, too, upon the backs of the toes. The hinder hand, therefore, hollows out a gulf between the anthropoids and the monkey; but the gulf between man and the anthropoids is wider.

Cuvier's reasoning was correct. The monkeys, and still more the anthropoids, deserve the name of quadrumana on condition that we do not understand the word *hand* in the rigorous sense that is given it in the case of man, but in the sense of an instrument that adapts itself to some kind of prehension. To us man alone has two real hands, as he alone among the Primates has two feet capable of supporting the entire weight of the body standing. When we suppose that the anthropoid is in a stage of advance toward a vertical position, we confound in him characteristics relative to the adaptation of the arm and forearm to the prehensile function and characteristics relative to the vertical attitude. If we suppress the former and whatever bears upon the

straightening of the trunk in arboreal life—a straightening which in no way implies a vertical position of the lower limbs—there is nothing left particularly to the credit of the anthropoids. The other distinctive characteristics of man and the anthropoids are secondary, but lead to the same conclusions. Hence the two groups should be separated in classification, and the anthropoids continue monkeys.

Employing Dalley's formula, we should say, but in an inverse sense, that the anthropoids differ from monkeys infinitely less than they differ from men. We need not even specify from what monkeys, whether pithecans or cebeans, for it is sometimes members of one, sometimes members of the other family, that are more removed from man. In the general shape of the skull, in a certain adaptation to the erect attitude of the head, in the development of the hemispheres above the cerebellum, and in still other characters, some of the cebeans are further advanced than the pithecans and the anthropoids. In short, taking the interval between the cebeans (arctopithecans excepted) and the pithecans as one, that between the pithecans and the anthropoids would be one, and that between the anthropoids alone or the cebeans, pithecans, and anthropoids together and man would be three.

Reasoning according to the monophyletic hypothesis, we suppose that man is derived from a single stock. But the possibility is suggested of his having had a multiple origin from different stocks, and possibly at different epochs. To determine this point, we must learn what the comparative study of races teaches us concerning the unity of the human species in the present and the past, from the lessons afforded by the actual remains of the races that have been produced by incessant minglings and changes during a succession of ages that defy all chronology.

We have shown that there are, properly speaking, no races within mankind such as we find among animals—that is, constant varieties, perpetuating their likes in a certain manner. There are only historical or philological elements of peoples to which we attribute, whether rightly or wrongly, a certain number of common physical characteristics. In any other sense the races of anthropology are simply products of our minds, suppositions of substantial affiliations of unmixed blood, working hypotheses. There are no persons corresponding with the types we assume.

These types themselves are not tangible realities, but groupings of characteristics which we suppose to have been continuing for an indefinite time through the events of history and prehistory which, without destroying the characteristics, have not ceased to scatter them and to arrange them anew in different combinations. As Lamarck has said, types are products of art; we pick them out as we can in existing populations. From particu-

lar types we rise to the notion of general types, which are likewise only probabilities, going up gradually to historical, prehistorical, and Quaternary types, and, by inductive constitution, to primitive types. Hence the necessity of a classification of types; or, to use the current erroneous language, of races. Every anthropologist has his classification. M. Deniker in his, published in 1889, admitted thirty types; in the classification of our lectures and our *Eléments d'anthropologie générale* we enumerated nineteen, without concealing the existence of many gaps. This is all not very favorable to the idea of the unity of the human species. But it must not be forgotten that a number of these types are artificial, provisional, and, as we have said, simple mental views. Whether these were originally one or many types, the results are the same. At present all men are capable of unlimited crossing, and new types are in continual formation. If we would go up to the origin of things, we should have to put away all these secondary products and simplify more and more. We should thus come, in the first stage of our synthesis, to the conception of eight general types, viz.: A fundamental European blonde type, a Mediterraneo-Semitic, a brachycephalic Asiatic, a dolichocephalic Asiatic, an Americo-Polynesian type, a black type with curly hair, a brachycephalic negro, and a dolichocephalic negro type. But perhaps dolichocephaly and brachycephaly are only secondary differentiations that may be produced in all the types, as large and small stature may be too; the black man with curly hair may be only a cross.

Nothing is easier, in fact, than to conceive in the light of anatomy and physiology that all types of mankind can be reduced to three original types—the Europeo-Semitic, the Asiatico-American, and the negro; or to two—the white, which is differentiated into those of flat and of sharp faces, and the negro. A further reduction would be hazardous. But if we lost ourselves in the depth of the ages, we might conceive the negro as first born and giving birth in succession to the curly-haired Australian, to one of the brown forms with straight or waving hair, and finally to the blonde European.

Hence, the monogenistic system, or the doctrine of the unity of type and origin, and the polygenistic system, or the doctrine of plurality of type and origin, are equally tenable.

But, it may be said, prehistoric skulls and bones should assist us in our task. Only a little! With the single exception of the Neanderthal skull, which has a type of its own, all the few specimens which the prehistoric peoples have left us are obviously only duplicates of existing types, and those of Europeans and Americans. Of the ancient negro, Africa and Oceania, which were supposed to be the promised lands for primitive anthropology, have

furnished us none. The most ancient man known to us by his bones is that one of Spy, which dates from the epoch of the mammoth. Yet it is demonstrated by flint implements that man primarily existed in both hemispheres. We see him, as the great Quaternary glaciers of Europe and America retired, going up toward the north. Europe was then only a narrow promontory which man traveled along in coming from Asia. That is all we know about our primitive ancestors. Beyond that we have no sure trace, no flints. The flints of Thenay are of the Roman epoch. To hazard a few conjectures respecting the Miocene ancestor, whether it was man or a precursor—one or the other certain, although direct proofs are wanting—we should be obliged to recur to the general probabilities furnished by natural history.

As we have seen, natural history proves indisputably that man is the issue of a Primate. It is opposed to the idea that we are descended from an anthropoid like those of the present time, although one of them—the chimpanzee—offers, perhaps, fewer objections to the supposition than the others. It furnishes arguments very favorable to the supposition that our stock comes from a Miocene monkey. It is not contrary to the theory of a direct descent from the lemurians, which were in their turn issue of the marsupials. But nowhere does it permit us to discern whether man came from one or two stocks, or originated at one epoch, or two epochs remote from one another.

The question whether the monkeys are of single or multiple origin is likewise not answered. According to MM. Vogt and Schmidt, the monkeys of the New World had not the same derivation as those of the Old World. This doctrine would support the theory of man having two origins, one common to Asia and America for the white and yellow races, the other on some southern continent joining Africa and Oceania for the negro.

Whether the moment of this origin be single or double, two periods are to be considered: one previous to the acquisition of language, in which the precursor of man is concerned; and the other after this, during which the real man was constituted. With the acquisition of speech a new life begins. Man, more able to associate with his fellows and to come to an understanding with them, would spread, become cosmopolitan, face every kind of climate, meet various necessities of existence, and thereby differentiate himself. This differentiation was all the easier, because his species was of more recent formation and less fixed, and because the media acted with certainty under those conditions. From that time the brain increased, the skull was transformed, prognathism diminished, and the facial angle opened.

But a new factor intervened at the same time. Till then the struggle for existence had been carried on by physical force; now

it is sustained by intelligence, and those with the best brains win the victory. While it is doubtful whether Darwin's natural selection can, in the existing conditions of the globe, engender new species separated by physiological barriers, it is certainly very efficacious to the improvement of the types within the species, and it constitutes one of the most powerful factors of progress. In this way to mediocre types have succeeded more and more favored types, whether by the general conformity of these forms to the aim to be met, or by the development of the brain in conformity to the increasing wants of man, and to the various kinds of life which he has made for himself. Adaptation, that marvelous natural force that rules the organic world as universal attraction rules the inorganic world, has performed its part as to him as well as to all animals—to each in view of its peculiar kind of life. With man the peculiar kind of life is the intellectual life.

We may illustrate the relations of man, the anthropoids, and the monkeys by comparing the order of Primates to a tree. The lemurians are the roots, giving rise to one or several stocks. One of these is the stock of the monkeys, one of the limbs of which sends up a higher branch—that of the anthropoids. Another branch, of which the point of its origin or contact with the preceding branch escapes our search, gives the actual human branch, which rises parallel to the anthropoid branch, has no relation to it, and passes beyond it.

Has man reached his culmination? Is he at the end of his evolution, or is he a little short of it? Will he suffer the fate of the paleontological species, which, having reached the maximum height of their lives, halted and perished, or will he continue to advance? Will his senses acquire greater delicacy, his hand more readiness? Will his brain gain in volume, or in convolutions, or in the number or the quality of its cells?

We doubt, regarding the equilibrium of the head and the harmony of its parts, whether the brain will gain greatly in volume. Its anterior lobes may perhaps increase till the axis of gravity passes the middle of the base of the skull. Dolichocephaly will be replaced by a universal brachycephaly. The quality of the cells is sure to improve. On that side no limits can be discerned, and in that direction man may hope to reach the Buddhist's ideal.

When man shall have thus been exalted by his intellectual faculties, the lower types nearest to him will have disappeared, and those animals which are now most closely related to him will be no more, and the interval between him and the other types will have widened to an unfathomable gulf.

Man, with some show of reason at last, intoxicated with his power, and looking down from his giddy height, may come to

fancy that he is a being without limitations, the center around which the universe gravitates, the sovereign for which all Nature has been created. He will, in fact, constitute a separate kingdom —the human kingdom.

Even then, in the midst of his triumphs, his body will continually call him back to himself, and the anatomist will still be able to cry to him, in words but little changed from an expression of Broca's, "Remember that you are one of the animals!"—*Translated for The Popular Science Monthly from the book L'Homme dans la Nature.*

BIRDS OF THE GRASS LANDS.

By Prof. SPENCER TROTTER.

AN eastern North American landscape is chiefly characterized, at least in the more settled portions of the country, by its diversified aspect of woods and fields. All other distant features gradually melt away and leave to the involuntarily closing eye a checkered expanse of darkly shaded masses and broadly open sunlit spaces. In the wilder parts, along the ranges and spurs of the Appalachians, the forests still hold undisputed sway over the fields, yet surely and rapidly the venerable woods are falling away as the axe sweeps with ever-widening swath along the clearing's edge. Year after year we have gone to some beloved spot of wilderness and learned to love the great, tall hemlocks that were ever whispering their secret to the wind. Some spring morning we are again at the old place; alas! what a pitiful sight awaits us! The giants of a hundred springs are fallen, and their long, white trunks and ghostly arms make a picture more desolate than the deepest gloom of the forest. To me the sighing of the hemlocks is a death song—a melancholy prophecy of the fate that awaits them.

The forest does not yield without a struggle. The tangled underwoods and seedlings so long stunted in the evergreen shade spring up with renewed life in the refreshing sunlight, and a sturdy "second growth" takes in a few years the place of the primeval forest. These are the woods of oak, hickory, and chestnut; of maple, birch, beech, and gum; of dogwood and sassafras, tulip, elm, ash, and linden, that invite us with their shade, their cool depths and reaches of sunlight, their fragrant blossoms and mystery of hidden things, from the broad fields of grass and grain that encompass them on every side.

Not less diverse than the woods and fields themselves are the living things that people them. Each offers its own peculiar environment and each has brought its own peculiar changes. There

are woodland flowers and flowers of the field, and flowers that grow on the border line among the briers and cripple as though undecided which dwelling place to choose, or lingering in the delights of both. Who ever found the mullein and the toadflax in the depths of a wood or picked an anemone in open fields? Yet there are flowers that find a congenial home in each, like the bluets, spring beauties, and the star of Bethlehem. In every province of life we find forms peculiar to the open grass lands and forms characteristic of the woodland, each "to the manner born."

These points of comparison apply especially to bird life. Every boy who has indulged the natural propensity to haunt running streams and wild, delectable places, to pursue shy birds and pry into the secret of their nests, knows full well that there are birds of the fields and birds of the woods. A student of ornithology soon learns that certain groups or families of birds are peculiar either to the woods or to the fields, and that their organization is in more or less entire accordance with the manner of life induced by the physical conditions of the area they inhabit. Among our Eastern American birds the titmice, wrens, creepers, nuthatches, wood warblers, tanagers, vireos, shrikes, waxwings, tyrant fly-catchers, the woodland group of thrushes, crows, jays, and woodpeckers are all tree-lovers, for the most part nesting in trees, and, if on or near the ground, usually in the depths of tangled underwood. On the other hand, a number of species belonging to the large family of the finches (sparrows, buntings, etc.) are strictly birds of the grass lands, and this is true also of some members of the closely allied family of starlings, blackbirds, and orioles, notably in the case of the field lark, some blackbirds, and the bobolink.

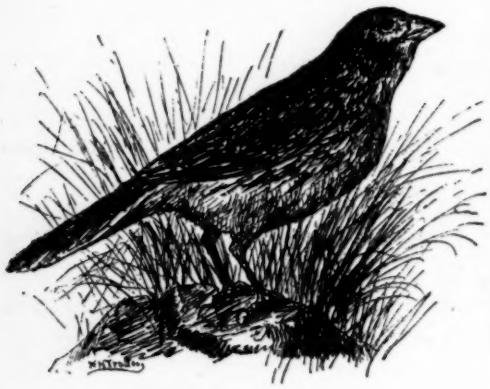

FIG. 1.—VESPER SPARROW.

Among the finches that are strictly grass-loving and dwellers in fields are three well-known Eastern species—the vesper, savanna, and grasshopper sparrows. The vesper sparrow, so called from its soft, rich song that fills the still evening air on upland pastures and immortalized by the pen of John Burroughs, is a familiar inhabitant of open fields and roadsides. Like most of its relatives it is a plain-colored bird, streaks of soft brown blending

into gray, but easily distinguished by the white-edged tail that it flirts open when started from the dusty highway or flitting before us along the fence-rows. In old fields and pastures the darker-streaked savanna sparrow and the little earth-colored grasshopper sparrow with its yellow-edged wings and dry, cricket-like song, start out of the grass beneath our feet; and if in June days we search long and patiently, a glimpse of a nest and its treasures may reward our pains.

FIG. 2.—SAVANNA SPARROW.

Every one knows the meadow lark stalking over fields of short grass or swiftly rising from weedy cover with sharp note of alarm; the bobolink with throat full of song hovering above the lush meadows and acres of waving herd's grass or gathering in dense autumnal flocks among the river reeds; the swamp blackbird with its brilliant epaulets of red; the shore lark and titlark—all these are birds of the open, grass-grown fields.

Glancing at a physical map of North America we see that the continent is characterized by regions of widely different aspect. By far the largest area is forest clad, including the vast territory east of the Mississippi Valley and the great portion of British America. West of this, and extending from the Gulf and the Mexican highlands northward to the Athabasca River, is the region of the great plains, rolling, grass-covered prairies, dry and treeless, except in the river bottoms of the eastern portion. To the west the plains rise into the greater plateau of the continent, a steppe region crowned by the lofty, pine-clad ranges of the Rocky Mountain system. Between this and the Sierra Nevada ranges lies an alkaline waste, the Great Desert Basin, while along the Pacific slope a forest region again prevails.

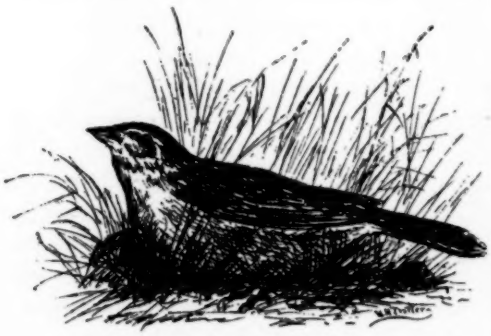

FIG. 3.—GRASSHOPPER SPARROW.

It is evident, from this hasty view of the entire continental area, that we have before us precisely the same factors, though on

a much larger scale and much more pronounced in character, as are present in the settled Eastern portion, namely, an open grass-covered region bordered by a vast forest. The same conditions hold good as in the case of the smaller areas of field and woodland, and we are not surprised to find differences in life of a corresponding nature. A fauna and flora distinct and characteristic of the prairie region on the one hand are in contrast with a more or less distinct forest life.

America at the time of its discovery presented a vast and unbroken expanse of forest embracing all the now cleared and thickly settled portions of the Eastern wooded region. Early explorers, as their records clearly show, were forcibly impressed with this endless reach of forest. The past two centuries have witnessed the steady downfall of the woods and their conversion over a wide territory into fields of grain and grass. Conditions of a prairie nature have, in other words, been introduced into the forest region, and we are naturally led to reflect upon the effect that this has had upon the life. When the region was one unbroken forest, where were the birds that to-day are found only in our fields?

Two solutions of this problem offer themselves to the mind. There has either been a radical change of habit among certain species in the past two hundred years, or an emigration and occupancy of the new lands have taken place from the prairie regions on the Western border. This latter view is, I think, the more probable from the fact that all the above-mentioned field birds are found on the plains or are represented there by varieties which differ only in slight shades of color.

Fig. 4.—Black-throated Bunting.

The range of the vesper sparrow covers the entire United States from the Atlantic to the Pacific and north to the plains of the Saskatchewan, so that it appears to be equally at home in the Eastern fields and on the Western praries. A paler variety occurs in the middle province, undoubtedly the result of the arid conditions of the region. Equally as extensive is the range of the savanna sparrow, though in the choice of localities it is not so entirely an upland bird as the vesper sparrow, haunting marshes along the coasts and river valleys as well as the higher open country. Several geographical races occur in the West and North. The little grasshopper spar-

row is another East and West form, spreading over the dry central plains and presenting a paler variety in the latter region. The familiar song sparrow, whose bright, cheery ditty enlivens the closing days of winter, though a haunter of garden shrubbery and brier patches, is a bird of the grass, building its nest upon the ground. It is widely distributed over the continent, and in the West is broken up into a number of geographical races.

A remarkably interesting case is that of the black-throated bunting or dicksissel. This bird is one of the most abundant species in the grass lands of the Mississippi Valley and on the prairies of Kansas and Nebraska. In the time of the ornithologist Wilson and to within fifteen or twenty years ago, it was an abundant bird in the fields of the Eastern States. Now it is rarely seen along the Atlantic seaboard. Some years ago I knew of several pairs breeding each spring in a restricted area in southeastern Pennsylvania. Timothy and clover fields were their favorite nesting places, and a bird-loving friend who had watched these pairs from year to year suggested a cause for their increasing scarcity. About the time the young were hatched the remorseless reaper appeared upon the scene, and the keen-edged knife soon laid waste the home of the unfortunate dicksissel. It was not long before these birds disappeared altogether from their once favorite fields, and a probable clew to the cause seemed to point toward the reaping machine. This I have never been able to verify, as the harvests on their prairie home must be equally as destructive unless a much larger territory or a difference in the times of hatching and reaping has prevented the rapid destruction of the young birds. Be this as it may, the evidence before us goes to show that the grass-loving dicksissel came early from the Western prairies to the newly opened fields of the East, and has abandoned them for its Western home, disgusted, we may imagine, with the innovations of civilized man.

FIG. 5.—MEADOW LARK.

The meadow lark of the East is replaced on the Western plains by a lighter form. Our curious cowbird, stealing its egg into the nests of other birds, is abundantly spread over the continent, and the remarkable habit of associating with cattle for the purpose of feeding upon the flies that swarm about them suggests the question, Was this habit acquired since the settlement of the country, or did the birds haunt the herds of buffalo on the

plains and begin to straggle eastward after the cattle were introduced? An allied form in the West, the yellow-headed blackbird, has similar habits, trooping among the cattle and horses on the plains, though it is a good householder, unlike the loose, vagabond cowbird.

The bobolink may have been a denizen of the river marshes of the East long before the discoverer first set foot upon these shores, though from its wide range toward the West, breeding on the plains of the Saskatchewan, we might infer that it had come eastward with the opening of the country. Similar conclusions might be adduced concerning the red-winged blackbird from its life and distribution, but it is a bird more of marshy land than of upland fields. Certain shore birds seem also to have taken advantage of the clearing of the country, as the killdeer and the grass plover, both being frequenters of plowed and fallow land.

Several characteristic prairie birds have at times by some accident found their way East, notably in the case of the lark finch, a beautiful Western form, and the yellow-headed blackbird above mentioned, both of which have wandered east as far as Massachusetts and Pennsylvania. This fact at least shows the capability of a bird to wander far from its original home, the regular phenomena of migration being still another proof.

Birds, owing to their superior organization and power of flight, have, more than any other forms of life, a constant tendency to widen their ranges and to occupy adjacent territory whenever the proper physical conditions are presented. This has been very clearly shown in the case of certain species along the Mexican border occupying the lands on which chaparral has lately grown up as a result of the invasion by cattle.* We can picture to ourselves a few prairie stragglers finding their way into the newly cleared lands of the settlers and gradually establishing themselves in the Eastern fields. By what route they came is a matter of conjecture—probably from the southwest in the northward-setting tide of the spring migration, or possibly by way of the Great Lakes and St. Lawrence Valley.

Thus has man in his history of progress and discovery unconsciously affected the distribution of other living beings. It is a very small fragment in the history of a country, but one of especial interest as showing how remotely and by what strange means causes and effects operate. Man appears in a new land, clears its face of timber, and erects his home. By and by the swift forsakes the hollow tree to build in the settler's chimney, and the swallow leaves the overhanging tree trunk or rocky ledge for the

* See a paper by S. N. Rhoads on The Birds of Southeastern Texas and Southern Arizona, etc. Proceedings of the Philadelphia Academy, January 26, 1892.

shelter of the eaves and barn. The robin builds within hand-reach of the doorsill, and the wren and martin, leaving their old homes in the forest to some woodpecker more lazy than his fellows, scold and quarrel for the possession of any hole or box, so long as it is near the dwelling place of man. Last, but by no means the least, this subtle influence reaches across a waste of tossing tree tops, and from the yet unknown prairie land come birds to dwell within his fields and gladden his heart with their sweet evening songs.

A MARINE BIOLOGICAL OBSERVATORY.*

By C. O. WHITMAN,
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IT is now twenty years since the memorable attempt to found a seaside laboratory on Penikese. Prof. Louis Agassiz lived long enough to demonstrate the impracticability of maintaining a summer school in such an inaccessible place, but unfortunately not long enough to repeat the experiment under more favorable conditions. The idea of transplanting the laboratory to the more convenient locality of Woods Holl, proposed by Alexander Agassiz, was abandoned on account of the little interest shown by the colleges which were appealed to for support. Although the continuance of this school was cut short by the untimely death of its master, the interest it awakened lived on and has brought forth a fairly rich crop of seaside laboratories.

About ten years after the abandonment of the Penikese School, Prof. Baird established, under the auspices of the United States Fish Commission, a marine laboratory at Woods Holl, and succeeded in getting a number of colleges interested in its support. For various reasons—beyond the control of Prof. Baird—the laboratory failed to attract the younger morphologists of the country. There was no lack of facilities, for these were superior to any that had ever before been offered in this country; and there was little lack of means, with the United States Government behind it, supplying money and a fleet of vessels such as no other station in the world has ever had at its command. Of late years, since the station passed into the hands of Colonel Marshall McDonald, its facilities for work have been increased, and a much larger number of morphologists take advantage of them every summer. The main functions of the station, however, continue, and must ever continue, to be devoted to the work of a great fish commission. No other like commission in the world has been able to

* Read before the American Society of Naturalists, December 28, 1892.

work on so grand a scale and with such immense effect. The results obtained each year reflect the highest credit on the management of the work and on the development of the vast field of economical interests charged to its care. The presence of such a powerful plant as this at Woods Holl adds very materially to the advantages of the situation.

The fact remains, however—and this is now conceded on all sides—that a marine biological observatory, devoted exclusively to research, must be independent of any control or interference on the part of the General Government, and rest on an endowment furnished by private initiative. This point has been strongly urged by Huxley, Carl Vogt, Herbert Spencer, and many others, and it may be put down as a settled fact. Of course, it does not follow that such an observatory may not receive support from the Government. Such support is, in fact, as important as it is fitting, as has been seen in the history of the station at Naples. The essential thing is that the observatory have an independent organization, and be able to direct its work to the ends of science, regardless of whether they coincide with those pursued by a commission of fish and fisheries. Although all biological investigation may, in fact must, minister directly or indirectly to the higher interests of humanity, its course must not be dominated or handicapped by utilitarian considerations. As I have said on another occasion: "A biological station should be a purely scientific affair from beginning to end. It should have no other aim than to advance science, and its whole organization should be directed to this one great end. We are urged by every consideration of the present, and every regard for the future of biological science in America, to keep this object steadily in view, and to allow nothing to block the way to its attainment" (first Report). Our course at Woods Holl in providing for instruction, as I hope time will demonstrate, is consistent with the end we are seeking.

The history of efforts to make Woods Holl a center for marine research, and the location there of the National Fish Commission, with resources that make it an ally of the greatest importance, are so much in favor of the place. Woods Holl is not, of course, the only available locality for our purpose, but it offers many natural advantages, and every summer's work has strengthened the conviction that we have been fortunate in our choice of position. Our experience simply confirms the opinion of the late Prof. Baird, that Woods Holl is *the* place of all the places on our coast for a marine station. It is easily reached by rail or by boat from New York, Boston, Providence, Fall River, or New Bedford. With Vineyard Sound in front, Buzzard's Bay behind, the beautiful Elizabeth Islands extending to the southwest, Martha's Vine-

yard in full sight a few miles away, Cottage City, Gay Head, and Nantucket in neighborly proximity, the environment is certainly not without attractive features. In the "gutters," "holes," and tidal currents; in the stretches of shore, varied and multiplied by "necks," rocky points, bays, flats, and adjacent islands; in a multitude of fresh-water basins and lakes completely isolated and inviting to experimental studies—in all these the naturalist finds a combination of natural advantages that is assuredly rare. One of the indispensable conditions to our work is *pure* sea-water, and that we find at Woods Holl, for there is no muddy river or city sewerage to vitiate it and drive away shore forms of life. The climate is cool and invigorating throughout the summer, and in the winter it is moderated by ocean temperatures. The fauna and flora are exceptionally rich for this latitude, and every year adds to the wealth of material which we can control for embryological purposes. The tropical seas, of course, offer greater riches in this respect; but the question we have to consider is this: *Where can an observatory best be placed to meet the needs of the greater number of biologists for summer work, and at the same time to best serve the ends of a permanent staff of investigators?* Accessibility and a stimulating climate outweigh all the advantages of a rich fauna and flora, when these must be accepted with a climate which, if not dangerous, is at least enervating, and when the locality is not within convenient reach. In fact, all such advantages can be added without neglecting the paramount considerations of health and availability. They can not only be added, but also multiplied almost without limit, by simply equipping a station with such means as will enable it to carry its research to any part of the Atlantic or Pacific coast, or even to the more remote seas of the earth. Such an equipment would be expensive, but is it not precisely what a biological observatory demands? No single locality, be it never so rich in life, can furnish more than an infinitesimal part of the wealth of the seas. *The only effective means of commanding extensive advantages in the way of select material is that of itinerary research.* This fact has been recognized and emphasized by those who have given most attention to marine work. Any plan for a great central station which does not include this all-important feature may be pronounced a failure in advance. Such provision must be equally necessary and equally expensive, whether the location be in the tropical or the temperate zone. If special material is required, it must be sought where it abides, be this one mile or twelve thousand from the center. Center there must be, and the more you limit the radius, the more local and the less satisfactory your facilities. Let the center be where the investigator can afford to spend his life, where his vitality is highest, and his energy most

productive. If desirable material calls him to a climate that induces lassitude and exposes him to infectious diseases, let his salary or the funds at his disposal for research be sufficient to enable him to choose his time and limit his stay to the necessities of the case.

Having said this much on the principles that must guide us to a wise choice of location, I must add a word on the tendency to scatter forces. On this point the words of Lacaze-Duthiers (Archives de Zoologie expérimentale et générale, tome ix, 1891, page 258), the distinguished director of the Marine Laboratory of Roscoff and Banyuls, are of interest. Speaking of the tendency to multiply seaside laboratories in France, he says: "We have been able to count as many as seventeen or eighteen stations on our coasts in the course of 1891. Are they all born to live? Will they all endure as long as the pompous announcements that have accompanied or preceded them would have us believe? Have not some discounted too quickly the future? . . . *Is this not also an exaggeration and a dissipation of precious energies, which, if concentrated into a single strong organization, might render very great service?*"

The survival of the fittest will in time answer these questions for us. But there is something to be said in favor of multiplying stations, if their creation be well considered, and determined with a view to *extend* rather than *duplicate* the facilities of a central station. Obviously a central station organized on a foundation that would permit of supplementing local by itinerary research would profit immensely by stations at favorable points, standing in auxiliary relations. Of such stations let us have all that we can possibly have without diverting either forces or funds that should go to make a strong common center. The danger lies, not in the possession of auxiliaries, but in the tendency to build up isolated laboratories in antagonistic rather than co-operative relations. In union there is strength, in division impotence. The advantages of a strong central station are so immeasurably superior to those of many weak local ones, that we are bound to encourage the former and discourage the latter. Our first effort should be to secure *one* foundation in the interest of *all*, rather than a multitude of isolated ones in the interest of individual colleges or universities. No university in this country can undertake to found a biological observatory for the whole country; but all can well afford to unite in the support of one founded by private munificence and open to all on equal terms. This is the only basis on which we can expect to secure an observatory of national importance. No scheme that ignores this simple, common-sense fact can ever lead to anything more than a small local success at the best. Now, I think every prominent naturalist in the country

will indorse the opinion that American biology would profit immensely more on the basis I have suggested than it could through any plan that would divide forces and build up weak college dependencies. Moreover, the individual interests of every institution in the country that maintains a biological department would be most economically and efficiently provided for in the same way. The interests of biologists, biological schools, and the science at large, all coincide in this matter, and each emphasizes and re-enforces the same verdict. Here we stand on principles that are too obvious, as it seems to me, to fail of commanding general assent.

This point dismissed, the task of finding a plan acceptable to all remains. Does any one of the marine laboratories now in existence afford a suitable vantage-ground for united action? This is a delicate matter to handle while rival schemes are afloat. But the question may at once be stripped of most of its difficulties by simply ruling out all schemes proposed in the interest of any particular institution and based on *local* organization. No disapprobation is intended for any one of these; they may all be useful and worthy of encouragement; but if they declare themselves organized under the auspices of some university or college, as most of them do, they certainly can make no just pretension to being national in aim and scope, and hence do not appeal to our highest need. And so, while wishing them all every possible success, we invite them to co-operate in a broader undertaking which will in no way encroach upon their private ground, but which, on the contrary, may extend and supplement their work, while sustaining facilities that are beyond their reach. Some of these laboratories, perhaps all of them, have offered their privileges to investigators from the outside, and it is to be hoped that they will continue to do so, for this forms an important part of the co-operation which a general observatory would invite and profit by.

The proposal recently made for the establishment of a biological observatory at Jamaica under the auspices of the British Government, aided by private subscription, is one to be strongly commended. Such an observatory would bring many important advantages to American as well as English biologists, and it might well be an international establishment. A national observatory on our coast, such as we have looked forward to, would find in a station at Jamaica an invaluable adjunct to its facilities, and might be expected not only to avail itself of its advantages, but also to lend it such support as its means might permit. The plan is in no way a rival or a substitute for the one already under way at Woods Holl. It would make no provision for instruction either for students or for beginners in investigation; its work would be

limited to research, and its workers would be few and for the most part transients in search of material to be taken away and worked up elsewhere. Its function, however, would be none the less important in subserving interests that could not otherwise be so conveniently and efficiently provided for. It ought, therefore, to receive the heartiest support from all who are interested in the advancement of biology.

Of the marine laboratories now in existence on our coast, the Marine Biological Laboratory holds a somewhat exceptional position, both in its organization and in its general aims. It owes its inception to some members of the Boston Society of Natural History acting in co-operation with the Woman's Educational Association of that city. It is controlled by a board of some twenty trustees, representing the following institutions: Harvard, Yale, Columbia, Princeton, Harvard Medical School, Massachusetts Institute of Technology, Williams College, University of Cincinnati, Bowdoin College, Boston Society of Natural History, the Missouri Botanical Garden of St. Louis, Philadelphia Academy of Science, University of Chicago, and the University of Toronto. This representative board has been extended every year until it may now be said to have a national character, including the majority of our leading biologists who are interested in marine work. Its officers of instruction have been taken from Harvard, Brown, Princeton, Clark, Chicago, Massachusetts Institute of Technology, Bryn Mawr, Cornell, Massachusetts Experiment Station, University of Nebraska, Boston Society of Natural History, University of Cincinnati, Ohio Wesleyan University, and the Allis Lake Laboratory. Its membership has extended to nearly all the more important educational institutions of the country. It represents the third attempt that has been made to unite our universities and colleges in the support of a marine laboratory. Mr. Alexander Agassiz made the first attempt as early as 1874, at the close of the last season at Penikese; and ten years later a second attempt was made by Prof. Baird. Although these efforts failed of their immediate object, they certainly prepared the way for whatever has been accomplished since. The aim from the outset has been to provide for both investigation and instruction, but for the latter as subsidiary to the former. The problem has been to combine the two in such relations that each would contribute most to the same end—the advancement of science. We have always kept in view the necessity of providing as early as possible a separate building for the exclusive use of investigators. Our effort from the beginning, as declared in every annual report, and as shown in every step thus far taken, has been to uphold a plan of national breadth; and it is on this basis that we have asked and received the support

of the colleges and the co-operation of investigators, and on the same ground we have rested every appeal for pecuniary assistance.

In certain respects of fundamental importance, then, the Marine Biological Laboratory stands alone among the seaside laboratories now in existence. Its general policy has been national in scope; the organization of its governing board and its staff of instructors is entirely non-sectional in character; it is an independent establishment, free from the control of any other institution, and owes its existence to private initiative; its record of five years has been such as to win the desired support of many of our leading colleges, and thus to place it on a vantage-ground that insures its development along the line of its choice.

Its growth in numbers and prosperity has far outrun expectation. Starting in 1888 with an attendance of seventeen, representing thirteen different institutions, it increased that number to forty-four in 1889, forty-seven in 1890, seventy-one in 1891, and one hundred and ten in 1892, representing fifty-two of our higher educational centers. The number of colleges, universities, seminaries, academies, schools, etc., represented during the five seasons is one hundred and ten. We now have thirty private rooms for the use of investigators, and five general laboratories for the use of students and beginners in investigation. Every room and every laboratory has been filled the past summer to overflowing, so that the library room had to be again occupied, notwithstanding the addition of new buildings more than doubling the capacity of the original laboratory. During the summer we have had no less than fifty investigators, over thirty of whom occupied rooms as independent workers. We can now point to scientific results that secure for the laboratory a reputation of which many a richer foundation might be envious.

With so encouraging a beginning already made, what option have we but to go on and build up on this basis, trusting that friends of our science will be found who will appreciate its work and its need and give it an adequate foundation?

Biology in America has many needs, but not one that rises to the importance of a marine observatory. In that its highest interests now center, and I am sure that I only express the conviction of my scientific colleagues, both in this country and abroad, when I say that the establishment of such an observatory is an object worthy of the most splendid gift that private munificence has ever bestowed on any branch of science. It costs many millions nowadays to create a first-class university; and not a few low-grade affairs might better have never been planted. Instead of multiplying such institutions, it would be wise to create scientific institutes for the larger and more important branches of

science. In this direction the benefactors of education and science have still almost everything to do. It is, in fact, the field that promises the greatest returns and the greatest blessings to mankind. As examples of what such institutes signify, may be mentioned the Pasteur Institute in Paris, the Zoölogical Station at Naples, the Lick Observatory, and the Smithsonian Institution. In what way could money bring swifter, surer, more magnificent, or more lasting rewards than when invested in such foundations? Our country suffers from the lack of these, while it is burdened with a plethora of impotent colleges. For this pathological overplus of colleges, secreting a sort of purulent education, with little or none of the saving basic properties of scientific culture, the best antitoxine would be the creation of research laboratories. There is no antagonism between scientific and literary education; but no one will now venture to deny that culture implies something more than a knowledge of words. Mr. Arnold's definition of culture—"to know the best that has been thought and said in the world"—needs the supplement furnished by Huxley: "Culture implies the possession of an ideal, and the habit of critically estimating the value of things by comparison with a theoretic standard. *Perfect culture should supply a complete theory of life, based upon a clear knowledge alike of its possibilities and of its limitations.*" "Observation and reflection"—the significant words with which Carl Ernst von Baer closed his Embryology of Animals—connote mental attributes that are the fundamentals of culture. They imply powers and habits best nurtured by scientific, but best polished and adorned by literary, training. Both means of culture are to be combined, but duly balanced. My plea is not against any source of culture, but against exaggerating one out of proportion with another. At present we are in desperate need of more science, and my appeal is in behalf of science in general, and biology in particular. I rejoice in the splendid gifts to astronomy, physics, and chemistry, but I feel impelled to urge that that great division of sciences, comprising the whole animate world, has claims upon the enlightened generosity of this country which have not yet been fairly met. The claim which I would place foremost at the present moment is the urgent need of an American marine biological observatory. What grander commemoration of the labors of Louis Agassiz at Penikese or of the efforts of Spencer F. Baird at Woods Holl, or what higher and more fitting tribute to the memory of the discoverer of this hemisphere, could this centennial year bring than the foundation of such an observatory? My humble plea is but the echo of a chorus of voices a thousand times more potent from the leading biologists of America and Europe. This weighty consensus of opinion shows so well how the scientific world regards this subject, and how broadly and

deeply the interests of science would be affected, that further remarks on my part would be superfluous.

THE OPINIONS OF VARIOUS AUTHORITIES IN SCIENCE ON THE PROPOSED MARINE OBSERVATORY.—Carl Vogt, the veteran biologist of Geneva, the friend and scientific colleague of the late Prof. Louis Agassiz, and the pioneer advocate of marine observatories in Europe, sets forth the aims and the importance of marine biology in the following letter:

UNIVERSITY OF GENEVA, *January 25, 1892.*

DEAR SIR: You ask my opinion concerning the utility of a marine biological laboratory with a view to enlarging and perfecting the one already established, on a plan too modest and limited, at Woods Holl.

I will not begin my letter with a word-quibble. But I believe that, in the actual state of science, institutions like the one you contemplate are not only of great and undoubted utility, but *absolutely necessary*. Neither theoretical and abstract science, nor the application of science to highly important practical ends, can achieve results of value without seriously and systematically supporting marine biological stations.

As you very truly remark in your letter, my convictions on this subject are not of recent date. I have entertained them for more than forty years—in fact, ever since the days when I devoted myself, alone and without other resources than my own activity, to biology, and carried on my studies for several consecutive years on the shores of the Atlantic and Mediterranean. For many years I vainly attempted to get the governments of maritime countries and trained biologists to carry out my ideas and projects. Some could not comprehend them, and to others they seemed eccentric. After years of fruitless attempts on my own part, I was happy to see the efforts of my friends who shared my views meet with success, and I continue to feel a pleasant satisfaction when I hear of the establishment of new stations whenever it is seriously undertaken. And I maintain that you are very fortunate in living in a country where the citizens are accustomed through their own private initiative to found institutions of interest to the public, where they know how to endow their institutions liberally, and often magnificently; whereas in our old continental Europe we can do nothing without the good will of the governments, which interest themselves in every undertaking, and lavish the better part of their revenues in sterile bounties on an unproductive military class.

But let us come down to facts. I maintain that marine stations are necessary for biological science, since nowhere but in the sea can there be found a host of types whose study is indispensable if one desires to form a clear and concise idea of the *ensemble* of the organic world, of which we ourselves are members. Now, the greater part of these organisms, vegetable as well as animal, are so delicate that, notwithstanding our improved methods of preservation, we can not acquire even an approximately correct idea of their characters unless they can be studied in their natural medium—the sea. We now enumerate along the coast of continental Europe almost as many laboratories as universities. Would these have been founded, often at great trouble and expense, if the need of them had not been urgently felt? And to mention only one branch of biological science—*morphology*—would this have reached the position which it occupies to-day were

we not in possession of marine biological laboratories, where most remarkable investigations have been and are still being carried on? To mention only the more important of these laboratories, where would morphology be without the works that have been produced in Naples, Roscoff, Banyuls, Wimereux, Marseilles, Villefranche, and so many other stations? In truth, those who would pretend that morphological science can advance and develop without the aid of these marine laboratories could equally well defend the paradox that astronomy can advance without the aid of observatories.

I need hardly say that I do not limit the term "morphology" to investigations in the structure and organization of the various organisms to be found in the sea; I would also include under it the most lofty questions and most abstract generalizations to which we are led by morphological research. Researches in organic evolution, to which Darwin has given so powerful and fruitful an impetus, can not be undertaken without due consideration of the marine fauna. The sea is really the source of organic life in its *ensemble;* researches on the relationships of different animals, on their origin, on their individual development, from the first visible germ to the completion of their life-cycle, are continually and necessarily leading us back to marine organisms. In order to form a conception of the development of the organic horizons as they extend through the successive periods of the history of our planet, we are obliged continually to recur to the comparative study of marine forms.

But the researches of present and future science are not limited to morphology and its conclusions. We demand a knowledge of the functions of the various organs whose structure has been studied, in order to understand the *rôle* which they played in the elaboration of life; we are desirous of knowing how the varied functions over which the organs preside are exercised. This is the aim of *physiological* investigation, which up to the present has been carried on only on man and a few animals predestined to experiment, such as the dog, the rabbit, and the frog.

I do not hesitate to say, if there were no marine laboratories in existence, they should be created for the prosecution of physiological investigation. In every case existing and future laboratories should be constructed in such a way as to admit of the carrying out of physiological experiments on a grand scale. The field is almost new; it has hardly been touched as yet, but the few works which have been produced in this line prove that most magnificent results await us in the future, and that general physiology will be quite as much enriched and even improved by means of such laboratories as has been the case with morphology. Many of my friends, themselves directors of marine laboratories, have felt the need of physiological equipment; many of them have expressed themselves to this effect in articles and other publications. In Naples they have taken a step in advance in this direction; but, to render these studies productive, delicate instruments are needed, apparatus costly beyond the means of existing laboratories. Will your fellow-countrymen furnish such means? It would be a glory to the United States could these projects there be realized, which have to be abandoned in other countries on account of insufficient resources.

You justly call your prospective laboratory "biological." I ardently wish that your countrymen, so nobly generous when it comes to founding scientific institutions, would saturate themselves with the meaning of the word "biological." *Biology* includes much more than morphology and physiology, which treat only of the mainsprings of individual life; it includes also the life of organisms in its totality; it should study the reciprocal relations which animals living in a

common medium bear to one another; their relations with their surroundings, and without which they would be unable to sustain the struggle for existence. Here, again, lies a field, little explored as yet, open to researches which have not only great scientific interest but immediate and undeniable practical value. I should perhaps surprise the public, who are in the habit of attributing to us *savants* a much greater fund of scientific knowledge than we really possess—I should perhaps surprise the public by maintaining that, with the exception of the herring and the sole, which have been studied of late years, we have only very fragmentary, incomplete, and insufficient knowledge of the life conditions of a host of marine animals, the fishery of which enriches so many industries and supplies us with so valuable a store of food. Our laws and regulations respecting marine fisheries (I speak only of continental Europe) are based on the vaguest notions—to a great extent only on suppositions or on analogies drawn from fresh-water fisheries. I am well aware of the fact that the settling of these questions, on the solution of which so largely depends the future of our fisheries, and with these the nourishment of our posterity—I am well aware of the fact, I say, that here also considerable resources are necessary: extensive aquaria, steam launches for long excursions—in short, all sorts of paraphernalia. But more requisite than all these are patient observers, indefatigable workers, who will not hesitate to devote years of labor to the solution of problems that may be summed up in a few words or even prove insoluble. I am convinced, however, that when once the utility—yes, the necessity—of such researches is generally recognized, citizens interested in the welfare and progress of their country will be found to furnish, some the financial resources, others the sustained intellectual labor.

Such are, to my mind, the aims of a marine biological laboratory. Has the utility, the necessity of such institutions been demonstrated? I trust that it has. I do not deny that the pursuit of these aims will require very considerable sums. I may add that the expense will be still further increased by the purchase and maintenance of an appropriate *library*. A neighboring library, to which access can not be had without some trouble, will not be sufficient. The investigators should be able while their work is in progress, to put their hands on all the books that can give them any information on the subject of their study. It is the possession of just such a library that assigns so important a rank to the station at Naples.

You have my best wishes, my dear sir, for the success of your enterprise. I sincerely hope that you will be assisted by your countrymen in every way, munificently, abundantly. You will pardon the length of my letter. If it contributes to the desired result, I shall be more than delighted. It will be a great joy to me in my old age to see arising on the other side of the Atlantic, through the free initiative of your fellow-countrymen, an institution destined to render great service to science, to the country, and to the people. With this wish I remain,

Yours sincerely, C. Vogt.

Prof. Huxley writes:

[London,] *October 30, 1891.*

Dear Sir: At this time of day, I do not think that a project for the establishment of a biological laboratory should need much advocacy. Biological problems are certainly before the public, and I hope that it is beginning to dawn upon the veriest Gigadibs of a *littérateur*, that the solutions of them are to be obtained by no book learned speculation however ingenious, but by patient appeal to Nature in the way of observation and experiment. I do not venture to say that

America needs to be reminded of this really fundamental truth more than England does; but, certainly, the greater proportion of new theories of the universe —gloriously unfettered by any acquaintance with realities—which periodically reach me, come from your side of the water; and I mourn over the waste of power and of ingenuity which might have been prevented by three months' work in a laboratory. I shall be very glad to hear of the success of your project; and all the more, that you propose to have it carried it out by private enterprise. I am yours very truly, T. H. HUXLEY.

NAPLES ZOÖLOGICAL STATION, *January, 1892.*

DEAR PROF. WHITMAN: You want my opinion on your plans regarding a large zoölogical station. I think my opinion has found long since an expression in a far more emphatic way than by ink on paper. Twenty and more years of life I have bestowed on creating and organizing such a station, and you know yourself how far I have met with success, part of which may even be recognized in your plan.

Two things concur to make a station flourishing: *money and good organization.* I have no authority to speak on your chance of finding money enough in your country for your plans; I only lay stress on the fact that money and a good deal of money is necessary to make a zoölogical station successful. It has been for many years my constant preoccupation to raise the income of the Naples station in order to satisfy all the wants science could wish for. I must leave to your appreciation, whether the organization, which I have given to my establishment recommends itself to others as satisfactory. I know myself well enough where it is defective, and how it might be improved; but I know also that there are circumstances in the way that can not be easily removed. As it is, however, it works tolerably well and has done in nineteen years of life some good service to science.

Should you succeed in raising money enough, I think you will be able to establish something so complete and so strong as to rival any existing establishment of the kind. I for one do wish you all possible success in your enterprise. Believe me, dear Prof. Whitman, yours most sincerely, ANTON DOHRN.

"Your project interests me greatly. Certainly such a station as you contemplate founding will be of the greatest importance to science."—AUGUST WEISMANN, *Freiburg.*

"An appeal to the 'upper ten thousand,' to the men who generously consider not only the needs of the commonwealth, but also those of intellectual progress, will not die away unheeded."—RUD. LEUCKART, *Leipsic.*

"Your communication concerning the erection on the North American coast of a large national marine laboratory as a common center for zoölogical and botanical, morphological and physiological investigations on marine organisms, has excited my keenest interest, and I hope that the considerable pecuniary support so necessary for such an undertaking will be forthcoming."—ERNST HAECKEL, *Jena.*

"I heartily sympathize with your desire to bring about the foundation of a laboratory on the United States coast for the use of skilled investigators in biology. . . . You ought to have at a favorable point on the American coast as complete and well-organized an institution as that established by our friend Dohrn at Naples."—E. RAY LANKESTER, *London.*

"I am convinced that such a station erected at a suitable point on the coast and fully equipped, but, above all things, under judicious management, will greatly further advancing biological science."—C. GEGENBAUR, *Heidelberg.*

"I fully believe that your countrymen, with their accustomed enterprise, will meet your present request."—G. B. HOWES, *London.*

"If you succeed in founding in the United States a biological institution in which the processes of life may be studied in all their magnitude and extent, you will indeed perform a lasting service to humanity."—C. LUDWIG, *Leipsic.*

"Speaking as a physiologist, I can hardly say anything too strong on behalf of marine laboratories such as the one you wish to establish."—M. FOSTER, *Cambridge, England.*

"I am glad to learn that your plans for the establishment of a permanent national marine laboratory are taking definite shape, and I hope their importance will be generally recognized. It would be strange if support could not be found for an American laboratory that will bear comparison with those of England, France, Germany, and Italy."—E. B. WILSON, *Columbia.*

"The need of a biological experiment station is even greater in this country than in Europe, where its importance has been recognized for a good many years, as shown in the numerous stations already established."—W. G. FARLOW, *Harvard.*

"I wish to be put down as one who favors the plan most emphatically. . . . I hope that steps will be taken to make the place a summer gathering ground for the biologists of this country in the broadest sense of the word—i. e., let us have investigations in zoölogy, physiology, botany, the study of the environment, both physical and chemical as well as experimental. Let it further be a national, not a sectional movement."—WILLIAM LIBBEY, JR., *Princeton.*

"I am glad that the Marine Biological Laboratory is taking steps toward securing a permanent and adequate endowment. I have watched its development with a good deal of interest, and have gladly contributed my mite for its support."—WILLIAM TRELEASE, *Missouri Botanical Garden.*

"I need hardly assure you of my deep and cordial interest in the permanent establishment of a seaside laboratory, and of my desire that the University of Illinois may share to the limit of its ability in its burdens and in the benefits to be derived from it."—S. A. FORBES, *Illinois State Laboratory of Natural History.*

"I am very deeply interested in the development of the laboratory at Woods Holl. I believe that it is in itself one of the most important educational institutions in the country, and I shall be glad to do all that I can to advance its interests."—DAVID S. JORDAN, *Menlo Park, Cal.*

IN the description of his journey into the interior of Iceland, published in Petermann's Mitteilungen, Th. Thoraddsen refers to the oases in the desert of volcanic sand at the foot of Mount Hecla. These are constantly changing or moving on account of the violent sand-storms which rage there. On the windward side they are encroached upon by the sand, and all vegetation is gradually destroyed, while on the other sides the grasses take root and "in a surprisingly short time barren and unfruitful spots are changed into good pasture."

THE ÆSTHETIC SENSE AND RELIGIOUS SENTIMENT IN ANIMALS.

By Prof. E. P. EVANS.

DR. WILKS reduces the chief difference between man and brute to the "smallness of knowledge of the fine arts possessed by the latter"; and a passing remark made by Prof. Huxley, in one of his essays, would seem to imply a disposition to draw the line of separation between animal and human intelligence at this point. Prantl regards the phrase "die Kunsttriebe der Thiere" as a metaphorical expression involving a confusion of terms, since animals, with all their apparent artistic ability and taste shown in constructing and decorating their habitations, do not seek to embody ideas in material forms—an assumption which begs the very question in dispute. Schiller, in his well-known poem, Die Künstler, makes man's pre-eminence consist solely in his artistic faculty:

"In Fleiss kann dich die Biene meistern,
In der Geschicklichkeit ein Wurm dien Lehrer sein,
Dein Wissen theilest du mit vorgezogenen Geistern,
Die Kunst, o Mensch, hast du allein."

In diligence the bee can master thee,
In skillfulness a worm thy teacher be,
Knowledge thou dost with higher spirits own,
But art, O man, thou dost possess alone.

Herbart, however, does not recognize this demarcation. "If one asks for a specific characteristic of mankind, which is not physical, but spiritual, original, and universal, and does not resolve itself into a more or less, I confess," he says, "that I do not know of any such distinction and do not think it exists." He then enumerates the advantages possessed by man—namely, hands, speech, and a long and helpless infancy, to the use and influence of which are due the extraordinary growth of the human brain in size and complexity and the corresponding development of intellectual power. In the acuteness of his senses and in many peculiarities of physical structure man is inferior to some of the lower animals. He has not, says Prof. Cope, kept pace with other mammals in the development of his teeth, which are "thoroughly primitive"; his nose is less serviceable than that of the dog; the eagle has a far better eye; the ankle joint of the sheep is, as a piece of mechanism, stronger and less liable to derangement than the corresponding joint in man; the horse's foot consists of a single compact elastic toe, on which the animal runs

while its heel is carried in the air and never touches the ground, thus attaining a springiness and swiftness of motion beyond the reach of the human plantigrade. Whatever lightness and elasticity of step man possesses is due less to the perfection of his bodily organism than to the uplifting influence of his intellect. With the decay of his mental powers *Homo sapiens* slouches like a bear, as may be observed in the ungainly and unsteady gait of cretins and idiots, however vigorous they may be physically.

The objection urged by Prof. Kedny against the doctrine of evolution—namely, that man's helpless infancy proves him to be different in kind from other animals—ignores the fact that the soko and many other species of the genus *simia* pass through a period of infant helplessness almost as long as that of some savage tribes. The babyhood of the anthropoid apes is much longer and more helpless than that of the cynopithecoids, the platyrhines, or the lemurs; and the higher the order of the monkeys, the more they resemble man in this respect. Mr. Wallace captured a young orang-outang, which had to be fed and cared for like a human infant, lay rolling on the ground with all fours in the air, and could hardly walk when it was three months old; whereas a macacus of the same age seemed to have already acquired full use of its limbs and mental faculties. The long duration of this complete dependence on parental care in the case of the human infant, so far from disproving the doctrine of evolution, furnishes one of the strongest arguments in its favor, since it helps to explain how man gradually attained his intellectual primacy among the primates. The American platyrhines, marmosets, and other smaller long-tailed monkeys reach maturity in three or four years, whereas the African dog-headed apes require ten or twelve years for their full development, and with the larger anthropoids this period of growth is nearly as long as with human beings.

The fact that quadrumana have flexible organs of prehension, can grasp and handle things and imitate human actions, gives them a great advantage over quadrupeds. A dog may be as intelligent as a chimpanzee, but he is unable to "show off" as well; he can not untie knots with his paws, nor put on clothes, nor eat with knife and fork, nor uncork bottles, nor drink wine by lifting the glass to his lips, nor use a toothpick, nor perform a variety of tricks which make the monkey appear to be relatively far more richly endowed with mental gifts than is actually the case, and throw into the shade the most conspicuous exploits of the poodle and the collie.

Nevertheless, this manual and digital dexterity can scarcely be overestimated as a means of disciplining the mind and increas-

ing the volume of the brain; and if chimpanzees, orang-outangs, and sokos had enjoyed the thousands of years of domestication and thorough breeding and training, from which dogs have so immensely profited, there is no knowing what advances in knowledge and acquisitions of intellectual culture they might not have made. It is wonderful how much they learn through observation and very slight instruction during a few months' intercourse with human beings, discharging with evident pleasure the duties of body servant or waiter, answering the door bell, showing visitors into the parlor, fetching water, kindling the fire, washing dishes, turning the spit, and doing all sorts of chores in and about the house. "Such an ape," said Brehm, "one can not treat as a beast, but must associate with as a man. Notwithstanding all the peculiarities it exhibits, it reveals in its nature and conduct so very much that is human, that one quite forgets the animal. Its body is that of a brute, but its intelligence is almost on a level with that of a common boor. It is absurd to attribute the actions of such a creature to unthinking imitation; it imitates, to be sure, but as a child imitates an adult, with understanding and judgment."

That the plastic and progressive period of the monkey's individual development is short, and that its faculties become set and stationary at a comparatively early age, is undeniable; but the same holds true of the negro, who loses his educability and ceases his mental growth much earlier than the Caucasian. The longer or shorter duration of this formative season in the mental life of man is, to some extent, a matter of race, but in a still greater degree the resultant of civilization.

The hand is also a valuable instrument for the cultivation of the æsthetic sense, and the more flexible and sensitive this instrument becomes, the greater are the results achieved by it in this direction. But there are animals without hands that show an appreciation of the beautiful. Mr. Darwin has proved conclusively that birds take pleasure in sweet sounds and in brilliant colors, and that the sentiment thus awakened and appealed to plays an important part in the preservation and perfection of the species through natural selection. The struggle for existence is not always carried on by fierce combat and the triumph of brute force, but quite as frequently takes the form of competition in beauty, addressing itself either to the ear as alluring song or to the eye as attractive plumage; and the bird that possesses these characteristics in the highest degree carries off the prize in the tournament of love, and propagates its kind.

There is no doubt that birds take delight in the gorgeousness of their own feathers, and the more brilliant their hues the greater the vanity they display. Conspicuous examples of this love of

admiration and fondness of parading their finery are the peacock and the bird of paradise.

The decoration of its boudoir by the bower bird, as described by Mr. Gould in his History of the Birds of New South Wales, indicates a decided and discriminative preference for bright and variegated objects, and evinces no small amount of æsthetic feeling and artistic taste in selecting and arranging them. The bower is built of sticks and slender twigs gracefully interwoven, so that the tapering points meet at the top, and adorned with the rose-colored tail feathers of the inca cockatoo and the gay plumes of other parrots, tinted shells, bleached bones, rags of divers hues, and whatever gaudy or glittering trinkets may please the bird's fancy. Sometimes the space in front of the bower is covered with half a bushel of things of this sort, laid out like a parterre with winding walks, in which the happy possessor of the garnered treasures struts about with the pride and pleasure of a connoisseur in a gallery of paintings, or a bibliophile who has his shelves filled with *incunabula* and other rare editions. These objects have often been brought from a great distance, and are of no possible use to the bird except as they gratify its love of the beautiful and appeal to what we call in man the æsthetic sense. Its conduct can be explained in no other way; for the bower is not a nest in which eggs are laid and hatched and young ones reared; it is a *salon* or place of social entertainment, and thus serves a distinctly ideal purpose.

The singing of birds, as a means of sexual attraction, implies a certain appreciation of melody. Indeed, many of them do not confine themselves to the songs of their species, but learn notes from other birds and snatches of tunes from musical instruments. Canaries can be taught a variety of airs by playing them repeatedly on a piano or on a hurdy-gurdy. They listen with attention and imitate the strains which take their fancy. If harmony or the concord of sweet sounds, as distinguished from melody or the simple succession of sweet sounds, does not enter into bird music, the same may be said of the music of primitive man and of all early nations. Savages, like feathered songsters, sing in unison, but not in accord.

Not only do some species of monkeys, like the chimpanzees and sokos, get up concerts of their own in the depths of the forest, but dogs, which are generally supposed to be decidedly unmusical, also discriminate between tunes and express their preferences or aversions in an unmistakable manner. A friend of mine, who had a magnificent St. Bernard dog, was fond of playing the violoncello. The dog used to lie quietly in the room with closed eyes, and appeared to pay no attention to the music until his master struck up a certain tune, when the dog immediately and invariably sat

up on his haunches and began to howl. If the tune which called forth such emotions had been written on a very high key, or characterized by shrill tones or harsh dissonances, the conduct of the dog might be easily explained. But such was not the case. There was nothing in this piece more than in any other, so far as any one could observe, that ought to grate the canine ear. Many incidents of this kind might be cited to prove that even dogs are not indifferent to musical compositions, and show a nice discrimination between them, having their likes and dislikes, as well as human beings.

The fertilization and propagation of many plants depend upon the existence of a sense of color in insects, and the exercise of choice in the selection of flowers. This preference implies a pleasure in certain hues, and consequently the possession of a rudimentary perception of beauty. Plants whose fecundation depends upon the action of the wind do not develop such a variety of colors as those in which this depends upon the agency of insects. Nature can trust her ill-favored daughters to the wooing of the wind, but if she wishes to attract a nicer class of suitors she must endow her children with brilliant qualities.

The power of distinguishing between colors has been denied not only to the lower animals, but also to the lower races of mankind. But a more extended and accurate knowledge shows that the conclusion is incorrect in both cases. We know that the American aborigines discriminate between the seven primary colors, and it is absurd to infer that this faculty was wanting to the Homeric men merely because we do not find all these colors mentioned in the Homeric poems. It has also been asserted that the ancient Assyrians could not distinguish green from blue or yellow, because no word was found for it in the remains of their language. But the tiles discovered at Nineveh prove that they had a very clear conception and æsthetic appreciation of the distinction between yellow, green, and blue, and probably did not confound any colors of the solar spectrum. The evidence of language on this point is purely negative and necessarily defective.

Even the religious sentiment, which has been assumed to be the peculiar possession of man, is faintly foreshadowed in the lower animals. The unanimity of opinion among those who have made the most careful study of this subject, and whose views are therefore entitled to the greatest consideration, is quite remarkable. M. A. de Quatrefages, in his *Rapport sur le Progrès de l'Anthropologie* (Paris, 1867, p. 85), maintains that "domestic animals are religious, since they readily obey those who appeal to them with the rod or with sugar." In other words, they are amenable to rewards and punishments, doing the will and seeking to win the favor of superior beings, on whom they are dependent,

propitiating and fawning upon them, creeping and groveling on the ground in abject adoration, in order to assuage their anger or to secure their kind regard. "There is no difference," adds the same author, "between the negro who worships a dangerous animal, and the dog who crouches at his master's feet to obtain pardon for a fault. . . . Animals fly to man for protection as a believer does to his god."

This is precisely the feeling of the savage in respect to the superior skill and power of the civilized man. *Taguta kipini te Atua*—doctor all the same as God—are the words in which the Morioris, or aborigines of the Chatham Islands, expressed their sense of dependence on a higher agency, whose beneficent workings they perceived but could not comprehend. Among rude tribes the sentiment of devotion to a chief does not differ essentially from that of devotion to a god; the Romans, at the height of their civilization, paid divine honors to their emperors; and in modern monarchies kings are officially addressed in terms of reverential awe and superlative adulation as all-wise and all-powerful beings, whose favor one can not sufficiently implore with servile words and suppliant knee.

"The feeling of religious devotion," says Darwin, "is a highly complex one, consisting of love, complete submission to an exalted and mysterious superior, a strong sense of dependence, fear, reverence, gratitude, hope for the future, and perhaps other elements. No being could experience so complex an emotion until advanced in his intellectual and moral faculties to at least a moderately high level. Nevertheless, we see some distinct approach to this state of mind in the deep love of a dog for his master, associated with complete submission, some fear, and perhaps other feelings."*

Comte held that the higher animals are capable of forming fetichistic conceptions, and of being strongly influenced by them. Herbert Spencer denies the truth of this statement in its absolute form, because it does not fit into his theory of the origin and evolution of religious ideas, but admits, what is essentially the same thing so far as the present discussion is concerned, that "the behavior of intelligent animals elucidates the genesis" of fetichism, and gives two illustrations of it. "One of these actions was that of a formidable beast, half mastiff, half bloodhound, belonging to friends of mine. While playing with a walking-stick, which had been given to him and which he had seized by the lower end, it happened that in his gambols he thrust the handle against the ground, the result being that the end he had in his mouth was forced against his palate. Giving a yelp, he dropped the stick,

* The Descent of Man. London, 1874, p. 95.

rushed to some distance from it, and betrayed a consternation which was particularly laughable in so large and ferocious-looking a creature. Only after cautious approaches and much hesitation was he induced again to lay hold of the stick. This behavior showed very clearly that the stick, while displaying none but the properties he was familiar with, was not regarded by him as an active agent, but that when it suddenly inflicted a pain in a way never before experienced from an inanimate object, he was led for the moment to class it with animate objects, and to regard it as capable of again doing him injury. Similarly, in the mind of the primitive man, knowing scarcely more of natural causation than a dog, the anomalous behavior of an object previously classed as inanimate suggests animation. The idea of voluntary action is made nascent, and there arises a tendency to regard the object with alarm, lest it should act in some other unexpected and perhaps mischievous way. The vague notion of animation thus aroused will obviously become a more definite notion as fast as the development of the ghost theory furnishes a specific agency to which the anomalous behavior can be ascribed."

This conduct of the dog, which every one must have observed under similar circumstances, corresponds to that of the savage who worshiped an anchor which had been cast ashore, and on which he had hurt himself when he first came in contact with it. Superstitious fear of this sort prevails most among men of the lowest order of intelligence, or in that stage of society in which human beings are psychically least removed from beasts. In proportion as they rise in the scale of existence and unfold their mental faculties, the more they free themselves from the tyranny of the supernatural. The terror of the dog hurt by the stick was out of all proportion to the pain inflicted, and arose solely from the fact that it was produced by a mysterious cause; it was fear intensified by the intervention of a ghostly element, and thus working upon the imagination it assumed the nature of religious awe. The case is analogous to that of a big, burly, brutal savage trembling before a rude stock or stone, or a Neapolitan bandit cowering before an image of the Virgin or kissing devoutly the feet of a crucifix.

The other illustration given by Herbert Spencer is that of a retriever, who, associating the fetching of game with the pleasure of the person to whom she brought it, would often fetch various objects and lay them at her master's feet; and "this had become in her mind an act of propitiation."

Still more interesting and instructive are Mr. Romanes's experiments with a Skye terrier. This dog, which was exceedingly intelligent and therefore an excellent subject for psychological study, "used to play with dry bones, by tossing them in the air,

throwing them to a distance, and generally giving them the appearance of animation, in order to give himself the ideal pleasure of worrying them. On one occasion, therefore, I tied a long and fine thread to a dry bone and gave him the latter to play with. After he had tossed it about for a short time I took the opportunity, when it had fallen at a distance from him and while he was following it up, of gently drawing it away from him by means of the long, invisible thread. Instantly his whole demeanor changed. The bone, which he had previously pretended to be alive, began to look as if it were really alive, and his astonishment knew no bounds. He first approached it with nervous caution, but, as the slow receding motion continued and he became quite certain that the movement could not be accounted for by any residuum of force which he had himself communicated, his astonishment developed into dread, and he ran to conceal himself under some articles of furniture, there to behold at a distance the 'uncanny' spectacle of a dry bone coming to life." In this instance we have the exercise of close observation, judgment, reason, and imagination culminating in the exhibition of superstitious fear—all the elements, in short, which constitute religious sentiment in its crudest form.

Animals are afraid of darkness for the same reason that children are. Thunder, lightning, and other violent meteorological phenomena, which inspire the primitive man with awe and therefore play a prominent part in the evolution of early mythology, produce a similar impression upon many of the lower animals, simply because they are mysterious noises which appeal to the imagination and stimulate the mythopœic faculty. Mr. Romanes states that "on one occasion, when a number of apples were being shot out of bags upon the wooden floor of an apple-room, the sound in the house as each bag was shot closely resembled that of distant thunder." A setter was greatly alarmed at the noise until he was taken to the apple-room and shown the cause of it, after which "his dread entirely left him, and on again returning to the house he listened to the rumbling with all cheerfulness." Dogs and horses can be completely cured of their fear of thunder by being present at artillery practice; they imagine that they now know what produces the dreadful roar, and are henceforth free from all apprehension concerning it.

To some extent this sense of the supernatural seems to enter into the sphere of pure imagination and to excite in the minds of animals those vague feelings of anxiety and alarm arising from mere figments of the brain and characterized as superstition. The following incident, "illustrating the instinctive fear of death and consciousness of its presence manifested by birds," is related by Buist: "A hen canary died, was buried, the nesting estab-

lishment broken up, the surviving cock bird removed to a new cage, and the hatching cage itself thoroughly cleansed and purified, and put aside till the following spring. Never, however, could any bird afterward endure being placed in that cage. They fought and struggled to get out, and, if all in vain their efforts, they moped, huddling close together, thoroughly unhappy, refusing to be comforted by any amount of sunshine, companionship, or dainty food." The experiment was tried with foreign birds, that had not been in the house when the death of the hen occurred, and could not, therefore, have known anything of the melancholy event by observation. The result, however, was always the same. "For the future that cage to them was haunted."

It is a common belief that many animals can see ghosts and future events. Justinus Kerner declares (Die Seherin von Prevorst, i, 125) that they are endowed with second sight, and that numerous facts can be adduced in proof of it. This uncanny faculty is supposed to be especially strong in dogs and horses. Storks, too, are known to have foreseen the burning of houses on which they had been wont to build their nests, and to have abandoned them, taking up their abode on other buildings or on trees in the vicinity. No sooner had the anticipated conflagration taken place, and a new house been erected on the same site, than they returned and built their nests on it as heretofore. That Balaam's ass perceived the angel, which was beyond the ken of the prophet, ought to suffice to convince every believer in the plenary inspiration of the Bible of the specter-seeing powers of the lower animals. The ghost stories told of dogs and horses are quite as numerous and well authenticated as those which have been told of men. There is no psychological theory of apparitions that does not explain these strange phenomena as satisfactorily in beasts as in human beings. The night side of Nature casts its gloom over both.

Of course, if religion is a direct and special revelation to man, then no sentient creature prior and inferior to him could have any share in it. The hypothesis of a pure primitive monotheism, of which all polytheistic systems of belief are mere distortions and degradations, would also tend to exclude the lower animals from the possession of religious sentiment by showing that the religious history of the race has been a downward instead of an upward movement, a corruption instead of an evolution. Its growth would not correspond to the growth of intelligence, and it could no longer be studied as a psychological phenomenon, but would be removed at once from the province of scientific investigation. There can be no science of the supernatural, since science recognizes only the operation of natural laws. A miracle that can be explained, as the rationalistic school of theology has

attempted to do, ceases thereby to be a miracle. The essence of religion is mystery; the sole aim of science is to clear up and thus do away with mysteries—a goal which it is always tending toward but will never reach, for the same reason that an asymptotic line never meets the curve which it is constantly approaching.

SCIENCE AS A FACTOR IN AGRICULTURE.*

By M. BERTHELOT,
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GULLIVER relates that in the course of his travels he found a curious country which was governed entirely by academies, according to the most exact rules of science and reason. These bodies had attempted to reform the whole social organization. For the superannuated principles of the old and good agriculture, especially, they had substituted ingenious inventions based on modern discoveries. This was a hundred and fifty years ago, when, instead of digging the ground by the old-fashioned processes, machines had been introduced by the aid of which one man could do the work of several. The cultivation of the soil was carried on by new methods, and the history of English agriculture in the eighteenth century shows that the author intended in the romance to criticise by his fable the first attempts at chemical cultivation. Fair weather and rain, according to the satire, did not escape the innovators. The flying island of Laputa, held suspended above any particular point, permitted it to be withdrawn or submitted at will to the action of the sun. In short, the people of this ideal country had everywhere suppressed or corrected the action of Nature. The effects of this conduct, says Swift, were not long in making themselves felt. The land was miserably devastated. The people, in rags, lived in ruined huts and were dying of hunger, while they were kept in obedience by terror.

Such is the view under which the writers of the day regarded the first preludes of scientific agriculture; and I do not know that there is any need of going very far to find well-informed persons still infected with similar prejudices. But the general opinion has changed; the benefits derived from science have been such, and they have so transformed society in the nineteenth century, that no enlightened mind would dare to-day to use the ironical language of the author of Gulliver.

In truth, I am not sure that our great-nephews may not suc-

* Presidential address before the National Agricultural Society of France, July 6, 1892.

ceed some day in finding a way of regulating the seasons; some Americans already profess to be able to produce rain at will by means of dynamite. But their hypotheses, resuscitated from the notions of the Romans concerning the influence of great battles on the atmosphere, do not seem to have as yet been confirmed by experiment. But, on the other hand, the innovations that were criticised so sharply by the English humorist are in our days becoming the bases of field labors.

Scientific agriculture is gradually becoming more fully substituted for the agriculture of tradition, and it is adding in an unanticipated degree to the wealth of nations.

To the progress of this art, which is more manifest every day, our society has never ceased to lend the most active aid, both through the individual labors of its members and by prizes and incentives offered by it to inventors. It has zealously given its assistance to all the great innovations foreseen in the last century by some advanced minds, which the literary critics of the time turned into derision, but which have been especially developed during the past fifty years.

The advance of material science has, in fact, served as the basis of this surprising metamorphosis of agricultural practices which we witness and admire; and the mental and moral advance of the human mind has likewise transformed under our very eyes the education of the peasant, now raised to the dignity of a citizen. Every day he is gaining a closer acquaintance with science; he is learning to take advantage of its teachings for the increase of his production and for the amelioration of the conditions of his formerly so miserable existence. Three sciences in particular have contributed to this evolution of agriculture—mechanics, chemistry, and physiology. The endlessly various agricultural machines permit us to sow, till, and harvest over large surfaces, and with a small expenditure of human manipulation. The productive force of Nature has thereby been wonderfully increased.

But the machines of themselves create nothing; they are only applied to products already elaborated under the operation of natural forces. The processes which preside at this elaboration, the manner in which the plants are fed at the expense of the air, water, and soil, to serve afterward as food for animals, have long been mysteries. It has hardly been a century since they began to be revealed to us by chemistry, which they could not have been earlier, so long as we were not acquainted with the real chemical elements common to plants and animals, and had not discovered the secret of their passage through living organisms. Chemistry exposed this secret when it disclosed the existence of the elements themselves; it has taught us to recognize them and to measure their proportions in plants and animals; it has established, first,

the fundamental and unforeseen truth that the combination of the elements under the form of organic compounds takes place only in plants to the exclusion of animals, for which plants are ultimately destined to serve as food. The mysteries of the production of useful plants and of the feeding of domestic animals have been unveiled by it; and these truths, so simple in our view, have been fruitful in applications.

Without enlarging upon a subject that would demand the most ample development, it will suffice to recollect that the constituent elements of plants have been divided into two groups: in one, such substances as oxygen, the carbon of carbonic acid, the hydrogen of water, and in a certain proportion the nitrogen of the air, are borrowed from the atmosphere, which can furnish them in unlimited quantities. Others, like the alkalies, lime, silica, iron, and a part of the nitrogen, are drawn from the soil. Removed with the crops, they should be restored to it, under penalty of a more or less rapid exhaustion. Each plant requires special elements; and it is necessary in its cultivation to be assured that the soil already has them, or to furnish them to it. Hence the long-disputed utility of chemical fertilizers; in them resides the whole secret of the indefinite maintenance of the land and the entire art of intensive cultivation.

But, while mechanics is a useful auxiliary to agriculture, and while the co-operation of chemistry is continually required, there is another science of still higher importance, because it presides over life itself in the animal as well as in the vegetable kingdom. You have named it *physiology*. You all know to what extent a knowledge of it is indispensable in order to define the conditions of animal and vegetable production, and to assure the normal development of living beings. You all know the importance of hygiene in society for securing the health of men and then of animals, and even of plants. Its function, long misconceived, is conspicuous now in all eyes; and it is one of the triumphs of science that it has been able to prolong the duration of human life, to secure immunity of our domestic animals against epidemics, and to extend its protection against the diseases which are destroying our field products and are threatening the annihilation of agricultural crops.

But the preservation of the products is not all. We need also to learn how to multiply productive beings; and in this field, too, science has, by the application of methods of selection, realized most marvelous progress in agriculture. Not only has intensive cultivation taught us how to draw a larger return than formerly from a particular soil and a given surface, but by the selection of seeds, we have doubled and tripled the formation of sugar in beet roots; by like selections, the production of the potato has

been augmented; and we are seeking, with certainty of success, yet more considerable increase in the production of wheat. No less progress is reached in the production of fruits and vegetables, and of cattle, to the daily amelioration of the general condition of the human race.

This advance has been promoted, partly by close acquaintance with the general laws of living Nature, as revealed by disinterested science—laws which are the essential foundation of every application; and equally, and in a way no less worthy of admiration, by the efforts of inventors, those men of practical ingenuity who labor at the same time for the increase of their own fortunes and for the good and profit of mankind.

But,besides discovering important scientific truths and devising profitable applications of them, the inventor needs to have a popular support; and it is, above all, important that the application of his inventions shall be made seriously by educated and intelligent populations, ready to receive and to propagate all useful ideas. To this end the sphere of public instruction has been enlarged; and, besides the elementary knowledge hitherto required, and the moral and civic precepts fitted to make intelligent voters, our educational schemes of the present time include fundamental scientific principles, the knowledge of which is indispensable for hygiene, industry, and agriculture. All civilized peoples have recognized the importance of such teaching, and democracies, more than any other governments, have thus expanded the courses of popular instruction.

The good old times of ignorance raised to a principle have passed away. Science can not be reserved for a narrow oligarchy; all should be associated in it to the greatest possible extent, because knowledge of that kind is necessary for the advancement of the applications, an advancement which is hindered by ignorance. It is so because it is important that all the citizens of a free country shall share in the highest ideal. No ideal is superior to that of agriculture. Country life is the normal type of human life. In it only can manhood be developed in its plenitude. Country life favors at once material health of the body and moral soundness of mind. The robust, industrious, and intelligent countryman has always constituted the strength of nations, and of France in particular; through him we have survived many trials and catastrophes; and through the countryman, active, intelligent, and instructive, we shall maintain the prosperity and greatness of our country.—*Translated for The Popular Science Monthly from the Revue Scientifique.*

HABITS OF THE GARTER SNAKE.

By ALFRED GOLDSBOROUGH MAYER.

WITH DRAWINGS BY THE AUTHOR.

AMONG those many creatures which know our fields and forests for their homes, is the little garter snake; or, as naturalists would have us dub him, *Eutænia sirtalis*. If one will but overcome a deep-rooted antipathy to crawling things, and will exchange the city's heat and turmoil for a few weeks of outing in the pure air of our sweet-scented fields, and make our little friend's acquaintance, much that the observer will not willingly forget will be his reward. When the snake is full grown, it is usually a little less than three feet long. The color is very variable, the usual body hues being brownish olive, sometimes with darker patches upon the sides, and generally there is a lighter yellowish streak down the middle of the back.

The belly plates are greenish blue or yellow, and the tongue is bright red, tipped with jet black. When angry, the snake spreads out its easily movable ribs, so as to make itself as broad and ugly as possible, and then one sees patches of white flecks between the scales on the sides. The general effect of the markings is so much like that of the ground upon which the reptile is crawling that even an observant naturalist rarely sees anything of his snakeship until he finds him almost under foot. All snakes crawl by side twists, and not by up and down undulations. They move themselves along by taking advantage of the friction between the sharp edges of the abdominal plates and the ground. The numerous ribs which can be moved forward and backward, as well as up and down, aid them greatly in their progress; and all the movements are performed with such gliding grace that one imagines the serpent to be impelled onward by some hidden, mysterious force. Place the snake upon a smooth glass surface, however, and it writhes and squirms in a helpless fashion. The garter snake is an excellent swimmer, making rapid progress through the water by means of a rhythmical sinusoidal movement of the submerged body, the little head being always just above the surface. It is a lazy creature, possessed of little desire to see the world, for it rarely wanders far from the place of its birth, as long as food remains abundant. It loves the sunny borders of swamps and ponds, where frogs and earthworms abound, and where it may bask ex-

FIG. 1.—HEAD OF GARTER SNAKE.

posed to the hot glare of the noonday sun, or seek a safe retreat beneath fallen logs or among the crevices of rocks. Its one idea is to warm up its cold blood by heat borrowed from the sun, and its life is one of apathetic indolence, except when in search of prey. Then the serpent steals stealthily through the grass; every now and again its slender neck elevates, and the cold, stony eyes dart a hasty glance to right and left. The red tongue flashes forth two or three times and it renews the search. And now, down beside the mossy bank of the brook, it espies a luckless frog, unconscious of the gliding foe behind. The snake half coils, then springs, and seizes its victim in a viselike grip. Struggles only serve to drive in the little needlelike teeth deeper and deeper, for they are all pointed backward, as one may see by looking at the picture of the skull (Fig. 2). The serpent recoils, dragging the resisting prey more and more hopelessly away from its watery retreat. The method of swallowing is a very simple one, although, if the frog be large, more than half an hour may be consumed in the process. The two bones of the lower jaw are separate and capable of independent movement; so the reptile loosens its hold upon one side of its jaw, and, pushing that side forward as far as possible, it drives the teeth in again, and then draws the jaw back to its original position. The result is that the prey is drawn down by the movement. The process is then repeated by the other half of the jaw, thus inevitably forcing the victim inward. The snake's skin stretches enormously, and the jaw is, of course, dislocated, but the extensible ligaments hold the bones together. The disproportion between the diameter of the frog and the serpent's slender neck is indeed marvelous, and snakes have been observed to split themselves open by attempting too ambitious a mouthful. After perhaps half an hour of laborious contortions, all that is seen of the poor frog is a great swelling that the contracting muscles are rapidly forcing down the reptile's neck. If one liberates the captured frog before it is too late, the wretched animal often seems so overcome by fear, or perhaps stupefied by the serpent's saliva, that it will not leap, but crawls in a painful manner. We must not allow ourselves to be duped into a mistaken sympathy, however, for such is the poetic justice of the case. Large frogs

FIG. 2.—SKULL OF GARTER SNAKE.

esteem small snakes a particular delicacy. After such a dinner as the above, the snake seeks some safe retreat and there lapses into a more or less quiescent state for about a week, at the end of which time it is ready to add another victim to its list. Frogs are not, however, the only food of the garter snakes; they will also feed upon newts or toads, they are very partial to earthworms, and in rare instances will resort to cannibalism. They never feed upon insects, and as far as my observation goes will not attack birds or mice. There is a great difference between the arrangement of the teeth in harmless and venomous snakes. The harmless garter snake, for example, possesses four rows of little needlelike teeth upon its upper jaw. All these teeth are of about the same size, and are pointed backward. A bite from such a snake would leave an impression similar to that shown in A, Fig. 3, where the dots represent the perforations made by the teeth. Venomous snakes, on the other hand, possess much fewer teeth, and in the outer rows we find several large fangs. An impression from a snake of this sort is shown in Fig. 3, B. Several times during the summer the garter snake molts. Almost a week before this takes place, the horny layer of the old epidermis begins to separate from the underlying skin. This separation is caused by numerous little hairlike structures, called lifting hairs, which develop uniformly all over the underlying epidermis and push the old skin away from it, so that it hangs loosely all over the body. The snake becomes torpid and irritable. The eyes lose their luster and become milky in appearance, for the cuticula over the eyes is shed also. Finally, the skin breaks around the lips and the serpent proceeds to cast it off, which it usually accomplishes in about an hour by writhing slowly through the grass, so that the whole skin is turned inside out, and pulled off backward like the finger of a glove.

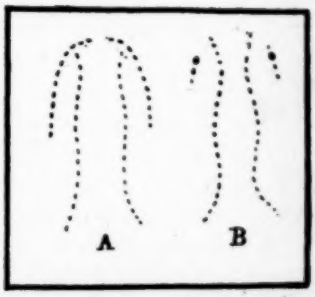

FIG. 3.—FORMS OF SNAKE-BITES.

The mating season of the garter snake comes about the middle of April, very soon after it awakens from the winter's hibernation. The males possess the mysterious power of tracking the females through the grass, and will follow after all the sinuosities of their paths with the greatest certainty. At this season both sexes emit a very rank and disgusting odor, especially when irritated.

During the months of June and July the females may be observed basking themselves in the hottest sun. They are very easily angered at this time, and generally make a bold front, snapping viciously at the intruder. They refuse to eat in cap-

tivity for about a month before the birth of the young, which usually occurs during the latter half of August. The young snakes are born alive, or rather break through their egg membranes immediately upon being born. The number of young produced by a single full-grown snake is usually about fifty, although, according to the observations of Mr. C. Tew Seiss, it may vary from thirteen to eighty. To give an idea of the enormous dangers which threaten the lives of the little snakes, it is easily calculated that if the garter snake arrive at maturity at the end of three years, and then produces an average of forty young at a birth, a single pair of mature snakes will have become the progenitors of over one hundred and seventy thousand at the end of the eighth year.

FIG. 4.—YOUNG GARTER SNAKE, ONE DAY OLD. Natural size.

The young serpents are usually about five and a half inches long; they are lively, active little fellows, colored very much like their parents, and have large, bright eyes, which give them a staring, surprised look, for snakes have no eyelids and can, therefore, never vary their expression. At the end of two or three days they grow hungry enough to eat, and will pounce upon and devour earthworms with much avidity. Very amusing indeed is it when two little snakes seize upon opposite ends of the same worm, for the fight only ends when one of the serpents attempts to swallow his brother, worm and all. Earthworms, however, can not be their only food, for the garter snake is exceedingly abundant where earthworms are very rare, as in the Canada woods. I have never observed the mother snake guard her progeny, and believe that the little ones scatter immediately to seek their fortunes.

Early in October the garter snakes huddle together in convenient crevices where they hibernate for the winter. As the food of the garter snake consists very largely of frogs and toads, it is probably an enemy to the agriculturist. If we examine carefully the leaves of our trees in late August it will be found that a perfect leaf is indeed rare; very few have escaped the ravages of numerous insect enemies. In this fact we find but another example of the great law of interdependence of organisms. The greatest enemies of the leaves are the insects; frogs and toads depend upon insects for their food, and snakes, in their turn, feed upon frogs and toads. So that we see that the more snakes the more insects, and the fewer perfect leaves will we find in late summer.

GHOST WORSHIP AND TREE WORSHIP.*

By GRANT ALLEN.

I.

FROM the myth of Attis itself, with its strange old-world implications, let us turn our attention next to the more general subject of plant and tree worship, of which the special case of the Phrygian god would appear to be only a particular example.

It will be evident at once from what has gone before that I accept on the whole, without reservation of any kind, Mr. Frazer's main view as to the importance of tree spirits and the soul of vegetation in early religions. But, then, I also accept as proved almost beyond the possibility of doubt Mr. Herbert Spencer's luminous theory of the origin of polytheism from ghost worship and ancestor worship. Not only do I believe that Mr. Spencer has adequately made good his main thesis of the derivation of gods from heroic ancestors, but I have also received considerable encouragement in my faith to this effect from Mr. William Simpson's brilliant and admirable paper on The Worship of Death, a paper much less widely known among thinkers on this subject than it deserves to be. Mr. Simpson, who is the well-known special artist of the Illustrated London News, has been led by his direct observations in the many lands he has visited in the performance of his duties to form independently a theory identical in every essential respect with Mr. Herbert Spencer's. Examination of temples, or their equivalents, in endless lands, from China to Peru, has convinced him at last that in almost every case the temple begins as a tomb or shrine of a dead person, and the worship is primarily offered to the actual ghost of the man or woman interred within it.

Now, between these two views—Mr. Spencer's and Mr. Frazer's—I am aware there would appear at first sight to be an immense discrepancy. I believe Mr. Frazer himself, in particular, would regard them as nothing short of absolutely irreconcilable. To judge from one pregnant passage in The Golden Bough (vol. i, p. 253), Mr. Frazer would appear to hold that the earliest gods of mankind in the hunting and pastoral stage of society took the form of animals, and that, in the agricultural stage, gods were envisaged rather as corn or fruit trees, or assumed the shape of a human being representing the corn or fruit spirit. I can find no-

* From The Attis of Caius Valerius Catullus. Translated into English Verse, with Dissertations on the Myth of Attis, on the Origin of Tree Worship, and on the Galliambic Metre, by Grant Allen, B. A., formerly Postmaster of Merton College, Oxford. London: David Nutt. 1892.

where in any part of his epoch-making work a single phrase which would lead me to suppose he would willingly accept the theory of the affiliation of tree gods and spirits generally upon the ghosts of dead ancestors. Nevertheless, I believe such an affiliation to be not only possible, but natural and provable. It is the object of the present Excursus, indeed, to show in brief outline that the tree spirit and the corn spirit, like most other deities, originate in the ghost of the deified ancestor.

Let us begin by examining and endeavoring to understand a few cases of tree spirits in various mythologies. Virgil tells us in the Third Æneid how, on a certain occasion, Æneas was offering a sacrifice on a tumulus crowned with dogwood and myrtle bushes. He endeavored to pluck up some of these by the roots, in order to cover the altar, as was customary, with leaf-clad branches. As he did so, the first bush which he tore up astounded him by exuding drops of liquid blood, which trickled and fell upon the soil beneath. He tried again, and again the tree bled human gore. On the third trial, a groan was heard proceeding from the tumulus, and a voice assured Æneas that the barrow on which he stood covered the murdered remains of his friend Polydorus.

Now, in this typical and highly illustrative myth—no doubt an ancient and well-known story incorporated by Virgil in his great poem—we see that the tree which grows upon a barrow is itself regarded as the representative and embodiment of the dead man's soul, just as elsewhere the snake which glides from the tomb of Anchises is regarded as the embodied spirit of the hero, and just as the owls and bats which haunt sepulchral caves are often identified in all parts of the world with the souls of the departed.

Similar stories of bleeding or speaking trees or bushes occur abundantly elsewhere. "When the oak is being felled," says Aubrey, in his Remaines of Gentilisme, page 247, "it gives a kind of shriekes and groanes that may be heard a mile off, as if it were the genius of the oak lamenting. E. Wyld, Esqr., hath heard it severall times." Certain Indians, says Bastian, dare not cut a particular plant, because there comes out of it a red juice which they take for its blood. I myself remember hearing as a boy in Canada that wherever *Sanguinaria canadensis*, the common American bloodroot, grew in the woods, an Indian had once been buried, and that the red drops of juice which exuded from the stem when one picked the flowers were the dead man's blood. In Samoa, says Mr. Turner,* the special abode of Tuifiti, King of Fiji, was a grove of large and durable afzelia trees. "No one

* Turner's Samoa, p. 63.

dared to cut that timber. A story is told of a party from Upolu who once attempted it, and the consequence was that blood flowed from the tree, and that the sacrilegious strangers all took ill and died." Till 1855, says Mannhardt, there was a sacred larch tree at Nauders in the Tyrol, which was thought to bleed whenever it was cut. In some of these cases, it is true, we do not know that the trees grew on tumuli, but this point is specially noticed about Polydorus's dogwood, and is probably implied in the Samoan case, as I gather from the title given to the spirit as King of Fiji.

In other instances, however, this doubt does not exist; we are expressly told it is the souls of the dead which are believed to animate the bleeding or speaking trees. "The Dieyerie tribe of South Australia," says Mr. Frazer, "regard as very sacred certain trees which are supposed to be their fathers transformed; hence they will not cut the trees down, and protest against settlers doing so."

Again, we must remember that most early worship is offered directly to the spirits of ancestors in the expectation of definite benefits to be derived from their aid. In New Guinea, for example, where religion has hardly progressed at all beyond the most primitive stage of direct ancestor worship, Mr. Chalmers tells us "when the natives begin planting, they first take a bunch of bananas and sugar cane, and go to the center of the plantation and call over the names of the dead belonging to their family, adding, 'There is your food, your bananas and sugar cane; let our food grow well and let it be plentiful. If it does not grow well and plentifully you all will be full of shame, and so shall we.'" *

Abundant other evidence could be forthcoming, were it necessary, to show that the ancestral spirits are regarded by the most primitive types of men as causing the earth to bring forth fruit in due season. But I hardly think further formal proof of this proposition necessary.

But how did the ancestral ghosts acquire in the first instance this peculiar power of causing growth in vegetation? The explanation, it seems to me, though crude and barbaric, is a very simple and natural one. In the first place, in many of the earlier and more native forms of sepulture, the dead are buried under a tumulus or barrow. Such tumuli, of course, go back in time to a remote antiquity. Now, many circumstances would make vegetation upon the turf of the barrows exceptionally luxuriant. In the first place, the soil there has been largely piled up and labored; it consists for the most part of an accumulation of deep vegetable mold, gathered together from all the surrounding surface; and at an age when cultivation was wholly unknown—for tumuli, we

* Chalmers. Work and Adventure in New Guinea, p. 85.

have reason to know from the example of Ohio, began in the hunting stage of humanity—the burial mound would be almost certainly conspicuous, from this cause alone, for its exceptional greenness. In the second place, again, the body within would add to its fertility, the more so as a great chief was seldom committed to the tomb alone, but was usually accompanied to the grave, whose megalithic stone chamber was to serve as his future palace, by his slaves, his wives, and his other belongings. In the third place, too, animals would be slaughtered, and feasts would take place at the newly made barrow. The blood of the victims on such occasions is habitually poured out on the grave, or on the surface of the altar stone; offerings of meat, of fruit, of milk, of oil, are made there in abundance by trembling worshipers. These offerings would act, of course, as rich manures, and would encourage on the barrows an unusual wealth and luxuriance of vegetation. But primitive man knows nothing of the nature and action of manure. To him, the fact that grass grew greener and bushes spread faster on the tumulus of the dead would almost inevitably appear as an effect immediately due to the supernatural power of the ghost or spirit who dwelt within it. In all probability, the savage would envisage to himself the actual herbs and shrubs which so sprang upon the tumulus as the direct embodiment of the soul of his ancestor, or his departed chieftain.

Now, it could hardly be expected that any direct evidence of so abstruse a point as this would be forthcoming from books or the accounts of travelers. Yet, fortunately, however, I have been lucky enough to hit in an unexpected place upon one curious little bit of actual confirmation of this *a priori* suggestion. In his excellent work on Nether Lochaber, the Rev. Alexander Stewart, of Ballachulish, quotes and translates a Gaelic MSS. poem, collected by Mr. Macdonald, the minister of the parish of Fortingall, in Perthshire, one stanza of which runs as follows:

"And ever he saw that his maidens paid
To the fairies their due on the *Fairy Knowe*,
Till the emerald sward was under the tread
As velvet soft and all aglow
With wild flowers such as fairies cull,
Weaving their garlands and wreaths for the dance when the moon is full!"

Upon this suggestive verse Mr. Stewart makes a curious and important comment.

"The allusion to paying—

'The fairies their due on the fairy knowe,'

has reference to the custom, common enough on the western mainland and in some of the Hebrides some fifty years ago, and

not altogether unknown perhaps even at the present day, of each maiden's pouring from her *cumanbleoghain*, or milking pail, evening and morning, on the fairy knowe, a little of the new-drawn milk from the cow, by way of propitiating the favor of the good people, and as a tribute the wisest, it was deemed, and most acceptable that could be rendered, and sooner or later sure to be repaid a thousandfold. The consequence was that these fairy knolls were clothed with a richer and more beautiful verdure than any other spot, howe or knowe, in the country, and the lacteal riches imbibed by the soil through this custom is even now visible in the vivid emerald green of a *shian* or fairy knoll whenever it is pointed out to you. This custom of pouring lacteal libations to the fairies on a particular spot deemed sacred to them, was known and practiced at some of the summer shielings in Lochaber within the memory of the people now living." *

Fully to appreciate the importance of this evidence we must remember that in almost every case, all over Britain, the "fairy knowe" is a chambered barrow, and that the fairies who emerge from it are the last fading relics in popular memory of the ghosts of stone age chiefs and chieftainesses. This idea, which I long ago put forward in an article in the Cornhill Magazine, entitled Who are the Fairies? has been proved to demonstration by Mr. Joseph Jacobs in the notes on the story of Childe Roland in his valuable collection of English Fairy Tales.

There is yet another way, however, in which the idea of special fertility must become necessarily connected in the savage mind with the graves of his ancestors. For we must remember that early worship almost invariably takes the form of offerings in kind at the tombs of dead chiefs or other revered persons. On this subject the Rev. Duff Macdonald, of Blantyre, in Central Africa (one of the ablest and most unprejudiced of missionary observers), says very significantly: "The ordinary offerings to the gods were just the ordinary food of the people.† The spirit of the deceased man is called Mulungu, and all the prayers and offerings of the living are presented to such spirits of the dead. It is here that we find the great center of native religion. The spirits of the dead are the gods of the living. It is the great tree at the veranda of the dead man's house that is their temple, and if no tree grow here they erect a little shade, and there perform their simple rites. If this spot become too public the offerings may be defiled, and the sanctuary will be removed to some carefully selected spot under some beautiful tree." In this we get some first hint of the origin of tree worship.

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* Rev. A. Stewart. Nether Lochaber, pp. 20, 21.

† Africana, vol. i, p. 89.

Now, the ordinary food of the living would of course include grains, seeds, such fruits as bananas, plantains, or melons, and many other vegetable objects. Mr. Macdonald adds the significant note: "It is not considered necessary that these offerings be taken away by the spirits. It is sufficient that they are placed there, that the spirits may come and lick them." * He further mentions that on these same graves fowls may be offered by cutting the throat, and making the blood flow down. "When the fowl is killed," says he, "they simply lay it down at the prayer tree." A goat may be offered in the same way, or milk may be poured out at the foot of the sacred banyan. What is the implication? Why, naturally, seeds placed in newly turned soil over a dead body, and richly manured with constant supplies of blood and milk, would germinate freely and produce unusually fine crops of grain or fruit. Is it suggesting too much to hint that, in this almost universal rite, we may even see the ultimate origin of cultivation? Primitive man, careless of the future as he is, would scarcely be likely deliberately to retain seeds from one year to the next for the purpose of sowing them. It is his habit rather to eat and destroy with lavish prodigality whatever he possesses in the pure recklessness of the moment. Something must first show him that seeds produce an increase before he can think of keeping them and deliberately planting them.

It has usually been held, to be sure, that cultivation must have taken its rise from the accident of chance seeds being scattered about in the neighborhood of the hut or of the domestic manure-heap—the barbaric kitchen midden. This may be so, of course; but it seems to me at least equally probable that cultivation should have begun through the offerings of grains and fruits and seeds at the graves or barrows of departed ancestors. Certainly we see that fruits and seeds are constantly so offered by existing savages. We know that they are deposited under conditions most favorable to their growth and productivity. And we can hardly doubt that the luxuriance of the vegetation so produced would greatly strike the mind of the early savage, and would be implicitly assigned to the productive power of his dead ancestors. I shall show in the sequel that the presence of an informing ghost or spirit of vegetation is even considered essential to the growth of crops by existing savages, and that human victims are slain by them for the mere purpose of providing such indwelling deities. The ghost in fact plays in the ideas of early man the same part that guano and phosphates play to-day in the ideas of the educated scientific farmer.

Nor is this all; I will even venture to go one step further. Is

* Africana, vol. i, p. 95.

it not at least possible that in the minds of early men the fruitfulness of the sown crop may seem to depend upon the presence beneath the soil of the deified ancestor? I do not mean physically, as manure, for that idea is, of course, quite beyond the savage, but magically and supernaturally, as ghost and spirit. At first sight, to be sure, this seems a somewhat large and uncertain postulate. But if we reflect upon the nature of the evidence collected by Mr. Frazer, we shall see, I think, that the transition is a sufficiently simple and natural one. Primitive man may well have begun by scattering seeds as offerings on the graves of his relations. If these seeds germinated and grew successfully, as they would be pretty certain to do, he would at once, as if by instinct, accept the increase as the immediate gift of the dead ancestor. For he knows nothing beforehand about the nature of seeds or the laws of their germination. He doesn't even know, to start with, that seeds are necessary for the production of food plants. From this first step, however, it would be but a slight advance deliberately to produce and bury a god for the express purpose of fertilizing a sown crop. That gods were so produced, slain, and buried in fields, to insure fertility, we know now for certain. "The Kandhs," says Sir William Hunter,* "have many deities—race gods, tribe gods, family gods, and a multitude of malignant spirits—each one of whom must be appeased with blood. But their great divinity is the earth god, who represents the productive energy of Nature. Twice each year, at sowing time and at harvest, and in all special seasons of distress, the earth god required a human sacrifice. The duty of providing the victims rested with the lower race of outcasts attached to the Kandh village. Brahmans and Kandhs were the only two classes exempted from being sacrificed; and an ancient rule ordained that the offering must be bought with a price. Men of the lower race, attached to the villages, kidnapped victims from the plains; and it was a mark of respectability for a Kandh hamlet to keep a small stock in reserve, as they said, 'to meet sudden demands for atonement.' The victim, on being brought to the hamlet, was welcomed at every threshold, daintily fed, and kindly treated, till the fatal day arrived. He was then solemnly sacrificed to the earth god; the Kandhs shouting in his dying ear: 'We bought you with a price; no sin rests with us.' His flesh and blood were distributed among the village lands, a fragment being solemnly buried in each field in the newly turned furrows."

This passage is sufficiently striking in itself as evidence for our purpose; but Mr. Frazer has further shown good grounds for believing that the *meriah*, or victim selected for this purpose,

* Imperial Gazetteer of India, vol. vii, p. 207.

was not merely "daintily fed and kindly treated," but was also regarded by the Kandhs themselves in the light of a god or divine personage. Indeed, Kandhs in distress often sold their own children for victims, "considering the beatification of their souls certain, and their death for the behefit of mankind the most honorable possible." "The victims," says Mr. Frazer, "being regarded as consecrated beings, were treated with extreme affection mingled with deference, and were welcomed wherever they went. A meriah youth, on attaining maturity, was generally given a wife who was herself usually a meriah or victim, and with her he received a portion of land and farm stock. . . . The periodical sacrifices were generally arranged by tribes and divisions of tribes, so that each head of a family was enabled once a year to procure a shred of flesh for his fields, generally about the time when his chief crop was laid down." *

Still more striking is the account of the way in which bits of the body were disposed of after the sacrifice. "Flesh cut from the victim was instantly taken home by the persons who had been deputed by each village to bring it. To secure its rapid arrival it was sometimes forwarded by relays of men, and conveyed with postal fleetness fifty or sixty miles. In each village, all who stayed at home fasted rigidly until the flesh arrived. The bearer deposited it in the place of public assembly, where it was received by the priest and the heads of families. The priest divided it into two portions, one of which he offered to the earth goddess by burying it in a hole in the ground, with his back turned, and without looking; then each man added a little earth to bury it, and the priest poured water on the spot from a full gourd." (Notice here the simulation of burial, the formation of a tumulus, and the pouring of libations.) "The other portion of flesh he divided into as many shares as there were heads of houses present. Each head of a house rolled his shred of flesh in leaves and buried it in his favorite field, placing it in the earth behind his back, and without looking." † The remainder of the body—head, bones, and bowels—was afterward burned on a funeral pile. The ashes were scattered over the fields, laid as paste over the houses and granaries, or mixed with the new corn to preserve it from insects. Here we would seem to have the superposition of a custom derived from cremation on a still earlier rite derived from burial and the formation of the barrow.

Of all these ceremonies, Mr. Frazer rightly remarks that they can not be explained as merely parts of a propitiatory sacrifice. The burial of the flesh by each householder in his own fields im-

* Frazer, *ubi supra*, vol. i, p. 385, quoting Macpherson, Memorials of Service in India, p. 115.

† The Golden Bough, vol. i, p. 385.

plies that to the body of the meriah there was rather ascribed "a direct or intrinsic power of making the crops to grow." In other words, the flesh and ashes of the victim were believed to be endowed with a magical or physical power of fertilizing the land. Again, intrinsic supernatural power as an attribute of the meriah appears in the sovereign virtue believed to reside in anything that came from his person, as his hair or spittle. The ascription of such power to the meriah indicates that he was much more than a mere man sacrificed to propitiate an angry deity. Once more, the extreme reverence paid him would point to the same conclusion. Major Campbell speaks of the meriah as "being regarded as something more than mortal"; and Major Macpherson says that "a species of reverence which it is not easy to distinguish from adoration is paid to him." In short, by common consent of our authorities, the meriah appears to have been regarded as himself divine.

To a certain extent, then, I would venture to differ, with all deference and humility, as of a scholar toward his master, from Mr. Frazer, in the explanation which he gives of this and sundry kindred ceremonies. To him the human god, who is so frequently sacrified for the benefit of the crops, is envisaged as primarily the embodiment of vegetation; I would make bold to suggest, on the contrary, that the corn or other crop is rather itself regarded as the embodiment or ghost of the divine personage.

Here are some more very striking cases that look that way, extracted once more from Mr. Frazer's vast repertory: "A West African queen used to sacrifice a man and woman in the month of March. They were killed with spades and hoes, and their bodies buried in the middle of a field which had just been tilled. At Lagos, in Guinea, it was the custom annually to impale a young girl alive, soon after the spring equinox, in order to secure good crops. Along with her were sacrificed sheep and goats, which with yams, heads of maize, and plantains, were hung on stakes on each side of her. The victims were bred up for the purpose in the king's seraglio, and their minds had been so powerfully wrought upon by the fetich men that they went cheerfully to their fate. A similar sacrifice is still annually offered at Benin, Guinea. The Marimos, a Bechuana tribe, sacrifice a human being for the crops. The victim chosen is generally a short, stout man. He is seized by violence, or intoxicated, and taken to the fields, where he is killed among the wheat to serve as 'seed' (so they phrase it). After his blood has coagulated in the sun, it is burned along with the frontal bone, the flesh attached to it, and the brain; the ashes are then scattered over the ground to fertilize it. The rest of the body is eaten."*

* The Golden Bough, vol. i, p. 383.

Now, it is true that in any case the identification of ghost and crop is very complete, for, as Mr. Frazer remarks, the Mexicans killed young victims for the young corn and old ones for the ripe corn. The Marimos thus sacrificed as "seed" a short fat man, the shortness of his stature corresponding to that of the young corn, his fatness to the condition which it is desired that the crops may attain. Again, says the same high authority, the identification of the victim with the corn comes out in the African custom of killing him with spades and hoes, and the Mexican custom of grinding him like corn between two stones. Still the point which I wish here particularly to suggest as important is, that cultivation may have begun on the actual tumuli of the dead, and that the annual god who was sacrificed for the fertility of the crops may have been, as it were, a deliberately designed and artificially produced deity, who replaced the ancestral spirit of early ages. Early man said to himself: "Food plants grew best where they grow on the grave of a divine chieftain: let us make such a grave in every field, and the spirit we put in it will insure fertility." Just as cultivation itself is a substitution of artificial for natural growth, so the annual slain god is, I believe, an artificial substitute for the natural dead chieftain in his sacrificial barrow.

As bearing once more on the supposed connection between ghosts and crops, which we shall presently see resolves itself later on into a connection between trees and crops, we might bring up the curious ceremony of the gardens of Adonis, which would seem to be a survival of the same idea that vegetation springs directly from the body of the divine person. The death of the Syrian god was annually lamented with bitter wailing by the women of the country. Images of Adonis, dressed to resemble corpses, and, no doubt, replacing the actual corpse of the original annual Adonis victim, as the Attis effigies replaced the original slain Attis, were carried out to burial, and then thrown into the sea or into springs of water. What is more noteworthy, however, is the fact that baskets or pots were filled with earth in which wheat, barley, lettuces, and various flowers—presumably anemones among the number—were sown and tended for eight days, chiefly by women. Fostered by the sun's heat, the plants shot up rapidly, but, having no depth of root, withered as rapidly away, and at the end of eight days were carried out with the images of the dead Adonis, and flung with them into the sea or into springs. We do not know whether these gardens were actually grown on the top of the effigies, but this would seem probable, says Mr. Frazer, from analogies elsewhere; for in Sicily the women, at the approach of Easter, sow wheat, lentils, and canary seed in plates, which are kept in the dark, and watered every second day. The plants shoot up quickly. The stalks are then tied

together with red ribbons, and the plates containing them are placed on the sepulchres, which with effigies of the dead Christ are made up in Roman Catholic and Greek churches on Good Friday. In both these cases the plants would seem to be envisaged as springing from the actual body of the dead god. Indeed, Eustathius speaks of the gardens of Adonis as being placed on the grave of the hero.*

Furthermore, another connection may be shown to exist between plants or trees and ghosts. We know that it is a frequent practice deliberately to put in herbs, shrubs, or trees on the graves of the dead. How far back in history or in savage life this practice may extend I am unfortunately not in a position to state. In Roman Catholic countries, however, the planting of flowers on the graves of the dead takes place usually on the *jour des morts*, a custom which would seem to argue for it an immense antiquity; for though it is usual among Catholics to explain the *jour des morts* as a *fête* of comparatively recent origin, definitely introduced by a particular saint at a particular period, its analogy to similar celebrations elsewhere shows that it is really a surviving relic of a very ancient form of Manes worship. In Algeria, again, I observed, the Arab women went on Fridays to plant flowers on the graves of their immediate dead; and the same point is noted about the same place by Miss Seguin.† The *koubbas*, or little dome-shaped tombs of Mohammedan saints, so common throughout North Africa, are almost always inclosed by a low stone wall, which marks off the *temenos*, and are usually overshadowed by palm trees deliberately planted there.

All through southern Europe, indeed, the cypress is the common emblem of the grave and the churchyard, as the yew is in our more northern climates. And this connection brings me more directly into closer contact with our proper subject, the pine tree of Attis. I think there is evidence that from a very early age evergreens of one sort or another were planted upon barrows. Those who have read The Golden Bough will not fail to see the significance of this pregnant association. Evergreens are plants which retain their vegetation—show the life of their tree spirit—through the long sleep of winter. The mistletoe, as Mr. Frazer has ably shown, owes its special sanctity to the fact that it holds, as it were, the soul of the tree in itself, while all the branches around it are bare and lifeless. As soon, then, as primitive men had begun definitely to associate the ghost or god with the idea of vegetation, nothing could be more natural for them than to plant such evergreens on graves or barrows. Now all through southern England we find many examples of round barrows planted with

* The Golden Bough, vol. i, p. 295.

† Walks in Algiers, p. 280.

Scotch firs. This is the more remarkable, as the Scotch fir is not considered by botanists an indigenous tree to southern Britain; nay, more, Mr. Darwin has shown that it can not live on open or exposed situations where deer or cattle graze unless it is protected by a fenced inclosure. Sheep and cows and stags nibble it down to the ground in its earliest ages, so that Scotch firs may be found in open spaces on English heaths, showing many annual rings of growth, but eaten close to the soil by the ever-active herbivores.* Hence we must conclude (since barrows stand for the most part in extremely open, heathy country) that not only were the Scotch firs deliberately planted on the tumuli, but also that they were carefully protected by fences till a relatively late or even historical period. A particularly fine example of a round barrow overgrown with ancient Scotch firs is to be found near St. Martha's Chapel at Guildford. Another, a little less striking, but equally characteristic, stands on the summit of Milton Heath, near Dorking. It is faced on the opposite side of the road by a second and extremely degraded barrow, also marked by a conspicuous clump of pine trees. A group of very ancient and gnarled Scotch firs, known as the Glory, on the hill just behind Dorking to the south, forms another and still more noble example of the same combination. But I need not labor the point. Whoever knows our southern counties knows that barrows and Scotch firs go together almost universally. Indeed, I believe there are no *very* old firs in Surrey, Kent, or Hampshire that do not so stand on antique tumuli.

Now, as these trees are not indigenous to southern England, and as they could only have grown under the protection of a fence, I conclude that the ancestors of the existing firs were planted there when the barrows were first formed, were long secured from harm by a belief in their sanctity, and have kept up their race ever since, either by seeds or shoots, under cover of the old trees, to the present day. The Scotch fir is in England the sacred tree of the barrows.

Have we here, then, I would venture to ask, the origin of the sacred pine tree of Attis? I incline to believe that we have. As the pine tree is planted upon tumuli in many parts of the world, and is often protected by walls or hedges, it would seem to be naturally associated with the ghost, and to become, in the expressive phrase used by Mr. Macdonald, the "prayer tree" of the departed.

This, then, I take it, is the true explanation of the prominent part which the pine tree plays in the myth and ritual of Attis. Nor is it any objection to our view that Attis is also apparently envisaged in an alternative form both as a man or god, and as

* Darwin, Origin of Species, p. 56.

an embodied corn spirit. Such frank inconsistencies, which to us would seem fatal to the success of any theory, appear perfectly natural to the easy-going mind of primitive man. To him, the ghost may reasonably appear in any one of many alternative forms. He recognizes it equally in the snake that glides from under the stones of the tumulus, in the beast or bird that crosses his path after the offering of prayer to his deified ancestor, in the shadowy form that eludes his prying gaze amid the dense shades of the primeval forest, and in the vague human shape that stands beside him in his dreams, and whispers into his ear uncertain warnings or dim promises for the future. So, too, with plants. From one point of view, Attis is the corn that springs directly from the dead god's body; but from another point of view he is the pine tree that grows with waving boughs above the grassy barrow of the self-slain or self-devoted hero. Whatever comes from the dead body, whatever seems to stand in close relation to it, is regarded in the simple philosophy of these *naïf* worshipers as an embodiment or representative of the multiform deity. Thus, in the extant descriptions of the ceremonies of the Attis festival, we get traces or glimpses of every one in turn among these alternative conceptions. Attis is first of all envisaged as a human being—a young man who dies a violent death in a particular fashion. This death by self-mutilation seems to point to a further development of the same idea which lies at the bottom of the Kandh practice of buying the victim and paying for him with a price—namely, it implies a certain obvious element of consent and self-sacrifice—a realization of the principle that "it is expedient that one man should die for the people." So the West African victims, we are told, went gladly to their doom; and so, too, in Phœnician and Carthaginian history we often find that in great crises of the state young men of good family volunteered to devote themselves as victims to Baal on behalf of the fatherland. Once more, after his death, Attis is changed into a pine tree; and his festival is inaugurated by cutting down just such a pine tree in the woods, which is accepted as in a certain sense the embodiment and representative of the dead Attis. But still the human embodiment remains side by side to the end with the vegetable one; for the effigy of a young man is also attached to the middle of the tree, as the young man himself was no doubt attached in still earlier practice. All this is comprehensible enough when we recollect that the original corn and the original pine tree may actually have grown out of the body or barrow of the self-devoted man god in earlier times, and that the ceremonies described for us by late classical writers represent very mitigated and modified forms of extremely ancient and savage rites.

There is also an interesting transitional stage, it seems to me,

between tree worship pure and simple and its offspring, grove worship. This transition from the special cult of the single tree to the general cult of the wood or forest, comes about, I take it, through the medium of the *temenos*. And what is the *temenos?* Well, I think, we get the first clew toward an answer to that question in Mr. William Simpson's brilliant identification of the temple and the tomb, already so well foreshadowed by Mr. Herbert Spencer. For if the temple is only a magnified tomb where offerings on a large scale are habitually made to the sainted ghost or the deified ancestor, then clearly the *temenos* is just the representative of the inclosed space surrounded by a wall about the primitive barrow. In the center stands the temple—that is to say, the actual tomb itself; all round it stand the sacred trees planted upon or about the holy grave, and regarded as the actual representatives of the deified hero. These trees form, I think, the great link of transition to the sacred grove. For when once people had grown accustomed to the prime idea that certain trees were to be considered as sacred from their close connection with a deified ancestor, it would be but a slight and natural step to regard other trees as sacred because they stood near a holy site, or even to manufacture an artificial sanctity by planting trees about a cenotaph temple. Thus, when Xenophon, for instance, built a temple to Artemis, and planted around it a grove of many kinds of fruit trees, and placed in it an altar and an image of the goddess, nobody for one moment would pretend to suppose that he erected it over the body of an actual dead Artemis. But the point is, that men would never have begun building temples and consecrating groves at all, if they had not first built houses for the dead god-chief, and planted trees and shrubs and flowers and gardens upon his venerated tumulus.

And this point leads me up to an important qualification. It is not necessarily true—nay, it is demonstrably false—that every individual god was originally a dead man. In late stages of culture, gods are quite unmistakably manufactured out of abstractions, as when the Roman Senate decreed in due form the erection of a temple to the purely factitious goddess Concordia. But nobody could ever have thought of making Concordia or any other like abstraction into a deity, unless they had been first thoroughly familiarized with the idea of many gods, derived originally from the deified ancestor or chief, and unless also these gods had already been envisaged as "departmental"—that is to say, as possessing certain definitely distributed functions and prerogatives over certain particular actions or portions of Nature. The possession of such special prerogatives, however, does not in the least militate against the primitive humanity of such departmental gods; for the Christian saints have often similar prerogatives,

and we know with certainty that most at least of the Christian saints were originally ordinary men and women.

To put it briefly, though there are individual gods who need not necessarily once have been individual men, there could be no such thing as the idea of a god except as the reflex of the ghost of man in general.

So, too, with temples. While it is almost certainly true that temples as a whole originate, as Mr. William Simpson has so abundantly proved, from the tomb of the deified chief or hero, it is also undoubtedly true that certain temples exist in later stages of culture which are, to use once more the phrase I employed above, cenotaph shrines. But these cenotaph shrines could never have come into existence at all unless men's minds had already long been habituated to the idea of worship at the actual tomb-shrine.

It is the same, again, with sacred stones. These, as I have endeavored to show elsewhere, owe their sanctity at first to the standing stones erected over the remains and tumuli of the dead. But in course of time prayer offered at the grave comes readily to be regarded as prayer offered to the visible and tangible object then and there present—the stone that crowns and tops the barrow. *Ghee* or oil poured out for the ghost comes readily to be regarded as offered rather to the stone itself than to the person whose grave it marks and commemorates. Especially will this confusion exist in the mind of the worshiper when the worship is of old date, and the personality of the deceased has been long forgotten. It is very early ancestors who become the great gods of later generations. Still no one could ever have dreamed of offering up food or preferring requests to a lifeless stone, unless he and his predecessors had long been accustomed to look upon similar stones as the dwelling places of his ancestors. But nowadays, when the sanctity of certain stones is already a well-established article of belief, the people of southern India—to take a particular instance—artificially manufacture sacred stones by setting them up in their fields, painting them red (a substitute for blood libations), and pouring offerings of oil or *ghee* on top of them. That is to say, they treat certain casual stones, which have no rational connection at all with their ancestral spirits, in exactly the same way in which they or their predecessors have been in the habit of treating the graves of their forefathers.

A like evolution has taken place, I believe, in the case of sacred trees and sacred groves. I do not mean for a moment to assert, or even to suggest, that every individual sacred tree grows or ever grew on the grave of a dead person. But I do mean to say that, so far as I can see, the notion of the sanctity of trees or plants could only have arisen in the first place from the reverence paid

to trees or plants which actually sprang from the remains of the dead, and so were regarded, like everything else that came out of the tomb, as embodiments or avatars of the dead man's spirit. Once such sanctity came to be generally recognized, however, it could be readily transferred to other conspicuous or remarkable trees, or even to trees in general, and particularly to the special groves or plantations that surrounded temples, whether mortuary or cenotaphic.

Yet in every case, when we go back far enough in time, or, what comes practically to the same thing, when we go down low enough in culture toward the savage level of primitive man, we find always that we stand nearer face to face with these the earliest naked realities of religion—that the ghost counts for most; that the temple has not progressed beyond the stage of the hut or underground dwelling; that the sacred stone is still the actual tombstone; that the altar is still the actual grave slab; that the sacred tree is still directly and intimately connected with the ghost or the tumulus.

[*To be continued.*]

NUMBER FORMS.

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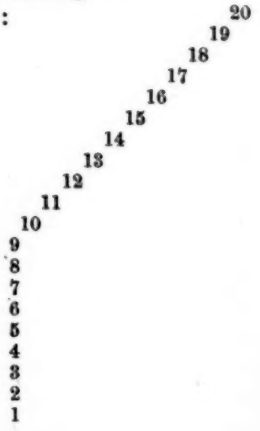
IN the Atlantic Monthly for February, 1873, Miss H. R. Hudson, writing on idiosyncrasies, says, "The nine digits *will* ascend in a straight line before my mind's eye, and the larger numbers *will* slant off at a queer angle" thus:



About twelve years ago Francis Galton, in England, while engaged in an investigation into the visualizing peculiarities of different persons, discovered that the possession of "number forms" was not uncommon. Some of these "forms" were given by him to the public in Nature for January 15, 1880, and afterward a collection of about sixty-five of them was published in his book on Inquiries into Human Faculty. These were accompanied by many descriptive details, but Galton did not attempt any complete explanation of the number form in general.

Neither is it the purpose of this article to attempt such an explanation, but rather to add to Galton's list some thirty-five or

forty forms, which I have incidentally collected during the last four years, together with some explanatory remarks and a few suggestions toward a future theory. It is hoped, too, that further attention may be called to the subject, and other contributions made to this curious chapter in psychology.

With about half a dozen exceptions, the accompanying forms have been gathered from college students of both sexes, varying in age from eighteen to twenty-five years. They are taken from drawings made in every case by the "seer" himself, in response to some such question as this: "When you think of the numbers

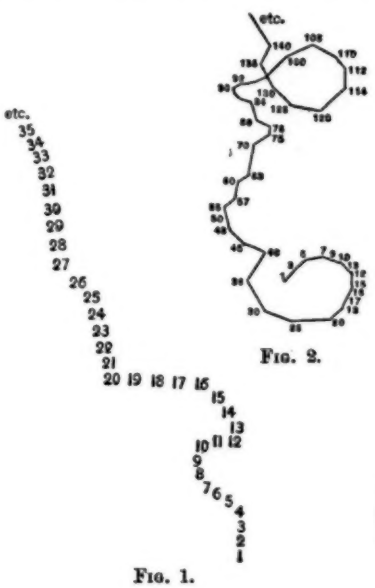


Fig. 1.

Fig. 2.

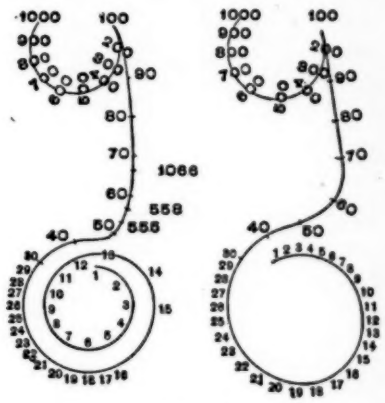


Fig. 3.

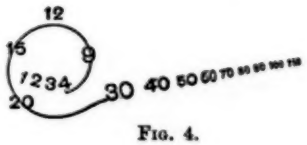


Fig. 4.

from 1 to 100, do you mentally *see* them in any form, or outline? If so, can you draw a representation of it?" At first about seventy-five students, of whom thirty were young women, were thus interrogated. In this examination it was probably understood that only well-defined and perhaps somewhat striking number forms were called for. As a result, only four forms were found, two from young women (Figs. 1 and 2) and two from young men (Figs. 3 and 4). This would correspond roughly with Galton's estimate that one out of every thirty adult males, and one out of every fifteen adult females, has a number form. My own later experience, however, has developed the fact that such a mode of investigation does not discover the full number of persons possessing forms, simple or complex. There are several reasons for this. The subject is not commonly understood when first presented. It would seem that a person having even a complicated number form might live and die without knowing it, or

at least without once fixing his attention upon it or speaking of it to his nearest friends, although such a one might use his form in daily computation. It seems to him quite natural to see the numbers in that way, and the thought may never enter his mind that others should see them differently. Again, if one is conscious of a peculiar form, he regards it as an idiosyncrasy and exhibits a certain shyness in revealing it. For this reason it is especially hard to get all the number forms from a company of children. They do not like to be laughed at, and will willingly keep silent about anything which they suspect may be another of those idiosyncrasies causing such mental torment to many children. Finally, those who do not have complicated forms are apt to think that the little curve, twist, or angle in which they see the numbers is quite too trifling a matter to mention. I am inclined to believe that one out of six adults would be a more accurate proportion, that the proportion among children would be still greater, and that it is perhaps a little more common among women than men.

FIG. 5.

The questions one would naturally ask a person having a number form are these: "How long have you seen the numbers in this way? Is the form fixed or is it changeable? What was its origin?" The answers to these questions are almost absolutely invariable. They would be as follows: "I have seen the numbers in this way ever since I can remember. The form is fixed and unchangeable. Its origin I do not know." In a very few cases when the nine digits always appear in mental vision as a mere straight line from left to right, the subject may conjecture that it originated with the printed forms from which they were learned. I have found that certain simple kinds of alphabet forms are very common. If a number of people be asked whether, when they think of the alphabet from *a* to *z*, they see it in a visual picture, and if so in what particular form, it will be found that a considerable number will say that they see the letters in one, two, or three vertical columns reading downward. A simple illustration is seen in Fig. 7. When there are two or three columns, the same letter always appears to a given person at the top of each column, but I have not found two forms alike except when they consist of a single straight line. In these cases the suggestion is often made by the seer that the letters were so arranged in his primer. Obviously this explanation would not apply to any such alphabet

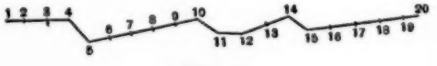


FIG. 6.

forms as are shown in Figs. 13, 15, and 16. Nevertheless, it is probable that all strongly eye-minded people, if they do not visualize the alphabet in any other way, visualize it as they do other things, in the form in which they had usually seen it.

Concerning the stability of number forms, any one may have his doubts removed by a few tests separated by months or years. In almost every case it will be found that, no matter how complicated the form may be, the subject, after one, two, or three years, will draw from his mental picture of it a copy differing in no essential respect from the original copy. The number form represented in Fig. 3 was given to me in 1889. In October, 1892, I requested of the young man by letter a second copy, and in reply received one precisely like the first. Other tests gave similar results. Galton testifies to the unchangeable character of number forms in all cases where they are well defined. It is true, however, that they sometimes disappear entirely. They are found to be more common among children than adults. It is probable that in children who are not naturally vivid visualizers, or in cases where it does not serve any useful purpose, the form fails to survive. One case of such a lapse I have found in an adult.

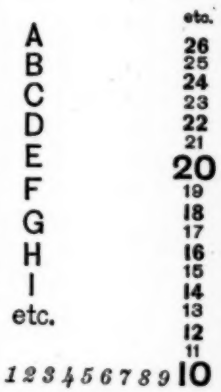


FIG. 7.

The general character of number form is such that a person having one can not think of the related numbers without *seeing* them in a definite visual picture. A form or outline rises involuntarily before his mind. In some cases the seer can describe it as definitely located in space in relation to his own body. It is two feet long or six inches long. It stares him in the face or lies at his feet. It recedes to the right or left, or into the distance. Others can not answer the question as to the location. In most cases, though not in all, no individual number can be thought of without seeing it in its appropriate place in the usual outline. Sometimes the form seems to be useful to its possessor in computations, particularly in addition and subtraction. In other cases it seems to have no use at all further than that of all mental imagery, which will be considered below. It has been suggested that it is by means of a number form, or at least by a clear visualization of numbers, that the arithmetical prodigies accomplish their remarkable computations. Though it has been shown that many of them do visualize the numbers, and mentally *see* the different steps of their problem, yet this alone offers

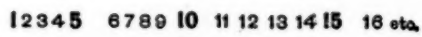


FIG. 8.

no adequate explanation of their mathematical agility. This hypothesis is further weakened by the recently developed fact that Inaudi, the ruling French mathematical wonder, is not a *visionnaire* at all, but a distinct *auditaire* who *hears* all his numbers.

Referring now to the accompanying forms, Figs. 1, 2, and 4 demand no further explanation. In Fig. 3 we have an interesting double form, the one to the left showing how the numbers from 1 to 15 appear when thought of by themselves or in connection with one another. But when any number below 15 is thought of in connection with any number above 15, it is seen as shown in the form to the right. Above 15 the numbers are unalterably fixed. The possessor of this form writes me as follows:

I do not believe I can think of a number apart from this outline. I refer all numbers to it, however large. One million is located where 1,000 is, and so of 1,000,000,000; 550 would be at 55 on the circle; 1,235 is at 35. You will notice that of the last two numbers I mention, the first is located at the point indicated by the first two figures, viz., 55; but the last number, 1,235, is located at 35, the last two figures. I can not explain this, but simply state it as a fact. I think possibly in large uneven numbers, I really, though almost unconsciously, separate the number into parts, in 1,235 the 1,200 either being ignored and my mind directed to 35, or else I in some manner connect the two locations but direct my attention more to one than the other. I stated above that I did not believe I could think of a number apart from this outline, and that is true when I think of some one number by itself and in adding and subtracting small numbers. If any one should ask me how many hours intervened from 3 to 11 o'clock, I would say 8, because I *see* that many on my number form, which immediately appears before my mind's eye, but I could not subtract 37 from 89 in that way. I would immediately locate the two numbers but I could not determine how many numbers intervened, and I find that in adding, subtracting, and multiplying odd numbers, and numbers beyond 15 say, I do it abstractly without referring to my form; but as I said, in thinking of any one number by itself, it is always connected with some point along that outline. This number form, by the way, stands upright and is about two feet in height—that is, the number 100 is two feet above 18 and about six inches to the right.

Among the seventy-five young men and women interrogated in the first experiment, was a rather diffident young woman who communicated to a classmate that while, she had no number form, there were certain associations that she always made with the nine digitis. Learning this, I questioned her, and she consented to write out the associations, which I reproduce here exactly as given:

1 = a child about two years old.

2 = a boy, ten or twelve years old, brown hair and eyes, frank, active, noisy, always ready to help.

3 = a girl, short hair, black, curly; sharp features, not pretty; slight; awful temper; shrill voice; bangs and slams around generally.

4 = a young lady, same characteristics as 2, but is calm, more quiet, studious, a home girl.

5 = a society girl, a policy girl, is always favored, has everything she wants; selfish; does not care how much trouble she makes other people; not always truthful.

6 = a young man, plain, matter-of-fact person, slow, good; will never amount to more than the average.

7 = a sort of villain; a schemer; dresses well, has polished manners, a good talker, bad habits; has a certain sense of honor; is able, but does not use his ability in the right direction; clear-cut features, tall, dark.

8 = a lecturer or clergyman; good, solemn, careful, very pious.

9 = a lady, hair rather gray, tall, soft low voice, sweet face, very well educated, dresses in soft colors; a truly refined woman.

No explanation of these peculiar associations could be offered. Each person arose in a distinct mental image whenever the corresponding digit was thought of. One notices, of course, that we have here the prevailing types of mankind as seen by a young girl. I have recently found another case quite similar. Here, also, the subject is a young woman, and she can give no explanation of the origin of her associations. In hearing or reading long numbers rapidly, she says that she does not have time to see the mental pictures, but single numbers, especially if written by herself, instantly call them up. The associations are as follows:

1 is without definite character, as is also 8, with the exception that the former reminds me of a short person, and the latter of a very stout person, but neither has sex or other characteristics.

2 is always a graceful woman, beautifully dressed. She is slender, with a beautiful delicate face.

3 is a chubby little girl, with dark eyes and bright quiet ways.

4 is a plain woman, rather tall, with pale hair brushed tightly back from a severe face. She is dressed very plainly, and the lines of her figure are angular. She is abstinent, intolerant, and hard to get along with.

5 is a man, dark, medium height, dressed in gray clothes. He is a business or professional man, successful and not particularly intellectual. 5 is always associated with the color gray.

6 is a pleasant-faced woman, medium height and stature, with hair brushed back plainly, and with quick, quiet ways. She is dressed plainly and neatly, and always looks pretty. She is an excellent housekeeper, and I think of her as engaged in household duties. I do not know the color of her hair.

7 is a man of quite opposite type from 5. He is very tall and dark, of musical or poetic temperament. I don't know how he is dressed, except that his whole figure is dark as I imagine him.

9 is another man, more like 7 than 5, also dark and dressed in black clothes. He is fine looking and a professional man.

To a class of twenty-nine students, of whom eight were young women, the following questions were recently given:

1. When you think of the numbers from 1 to 100, do you see them in any particular form? If so, will you write or draw it on paper?
2. When you think of the alphabet from *a* to *z*, do you see the letters in any particular form?
3. Have you any associations of color with the numbers or letters?

To these questions twenty-nine written answers were received, disclosing four number forms and a few simple alphabet forms. Immediately afterward, however, two others of the class told me privately that they thought they did have forms, although they had not reported them in writing. These were found, indeed, to be perfectly well defined, and are shown in Figs. 6 and 7. The other four are shown in Figs. 5, 8, 9, and 10 (*a*). One curious alphabet form was found (Fig. 10, *a*), but no color associations. This method of inquiry revealed in this case, at least, a much larger percentage of number forms than that given by Galton. These six forms present also some new types. Fig. 5 is from a young man, who sees only the numbers 5, 6, 7, 8, and 9. Of these, 7 is by far the most conspicuous, and is described as a black figure, fine and perfectly formed, standing on a reddish background. 6 and 8 are less distinct; 5 and 9 still less. Fig. 7 shows the number form of a young man, who sees the numbers from 1 to 9 in Italics on a horizontal line. The others are straight and form a right angle with the first. All the odd numbers appear to him as weak, affording in counting unsatisfactory places to stop. The

1	2	3	4	5	6	7	8	9	10
10	20	30	40	50	60	70	80	90	100
11	21	31	41	51	61	71	81	91	1000
12	22	32	42	52	62	72	82	92	10000
13	23	33	43	53	63	73	83	93	100000
14	24	34	44	54	64	74	84	94	1000000
15	25	35	45	55	65	75	85	95	10000000
16	26	36	46	56	66	76	86	96	100000000
17	27	37	47	57	67	77	87	97	1000000000
18	28	38	48	58	68	78	88	98	10000000000
19	29	39	49	59	69	79	89	99	100000000000

FIG. 9.

even numbers are firm and strong, while 10 and its multiples are much larger and more prominent.

Fig. 8 is from a young woman who sees the numbers in a straight line; 1, 5, 10, 15, etc., appearing more distinct than the others, with wider spaces after 5 and its multiples.

One of the most interesting forms in this collection is that shown in Fig. 10 (*a*). This young man sees only 1 and 0 distinctly; 2 and 9 stand in their proper places, but are less distinct;

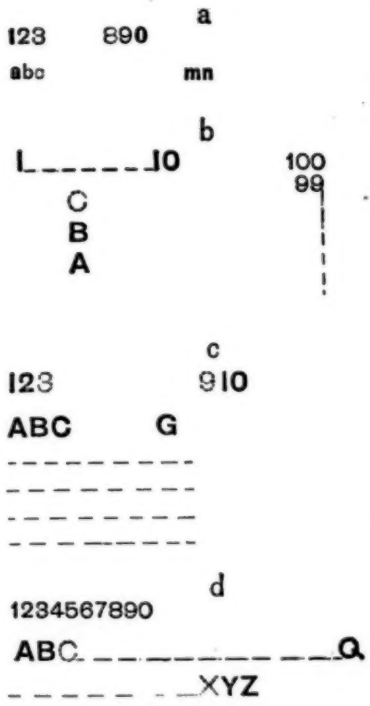


Fig. 10.

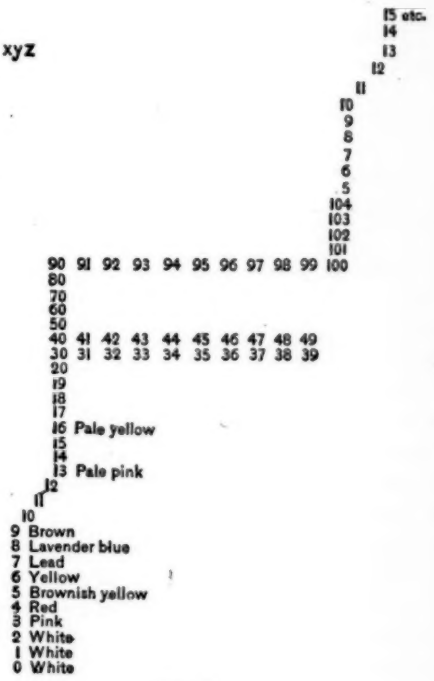


Fig. 11.

while 3 and 8 are seen but faintly in a shadowy form. The intervening figures are not seen at all, but the appropriate *space* for them is there. His alphabet form accompanying discloses the

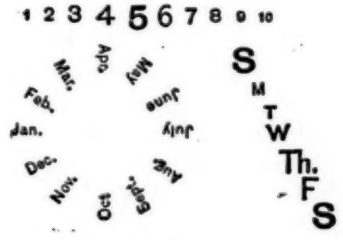


Fig. 12.

Fig. 13.

same principle. *A*, *m*, *n*, and *s* are very distinct; *b* and *y* are fainter; *c* and *x* are shadowy; a blank space intervenes, sufficient for the other letters. This young man has a brother and two sis-

ters, whom he severally asked concerning their views of the letters and figures, without mentioning his own. The forms shown in Fig. 10 (*b*), (*c*), and (*d*) are the results. The brothers and sisters differ widely in age, did not learn their letters or figures from the

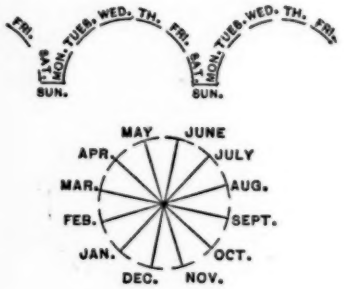


Fig. 14.

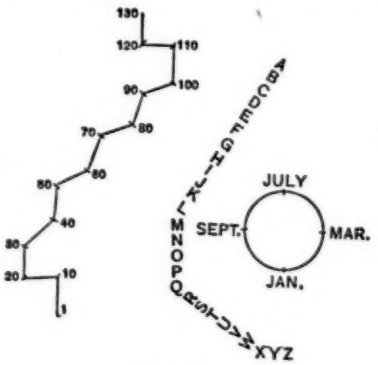


Fig. 15.

same books, and had never, until this time, spoken of their forms to one another. The very striking similarity, together with the odd character of the forms, shows strong hereditary tendencies in this case. There are other instances of family likeness in number forms. It is not, however, invariable. Figs. 2, 12, 14, 15, and 16 are forms from members of one family. There are some similarities, but they are not striking.

Fig. 11 shows the number form of a girl of nine years. This is a colored form, its peculiarity consisting in the fact that the numbers containing two or more figures maintain their individuality and appear in a color formed by mixing the colors of its constituent digits. Thus 13 is not white and pink but pale pink. Other colored or partly colored forms appear in Figs. 17 and 18. In the former, 5 is scarlet, while the other numbers are not seen in colors. This form, like that in Fig. 4, lies in space of three dimensions, and like that of Fig. 10 has some faint and some missing numbers. Other peculiarities of this form are best presented in the words of the seer herself:

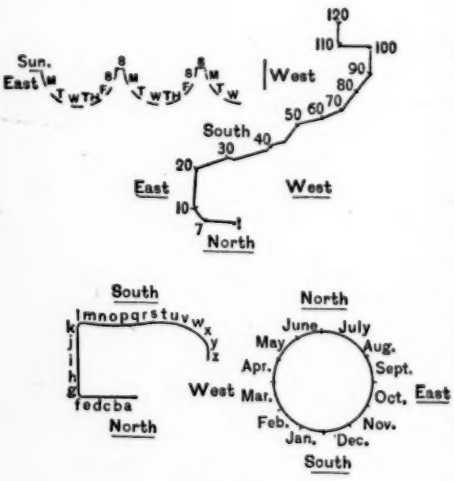


Fig. 16.

In all these forms the figures and letters appear to me in my own handwriting, except in the divisions of the day. In these, I have the abstract idea of morning, etc., in mind, but with the distinct divisions as in the diagram. All the plans are very much larger than here represented. The figures begin at my left and cross to my right before me, curving at 8; and 1,000 seems about my fingertips when my arm is extended straight before me. The circle of the seasons is about as large as would lie between my arms extended straight before me. The days of the week occupy a line at my left, about a yard long. The divisions of the day are perpendicular, as though hung on a wall, and morning begins at a level with my hand.

The number form in Fig. 18 is peculiar in this respect, that it reads from right to left. The seer is an artist, and it may be worth mentioning that she is not left-handed. Other features of her form she describes as follows:

The line of the figures runs down to 8, 18, 28, 38, 48. They turn and ascend to the multiples of 10, but after 40 I see only the numbers found in the multiplication table—42, 48, etc. The numbers 18 and 19 form a very dark corner; 20 is quite light; 24 again is dark, the darkness continuing to 30; 30 is again light, and the numbers following are all quite light. The source of light seems to be 60, which is much higher than the rest, the light touching those on either side; 75 is very distinct.

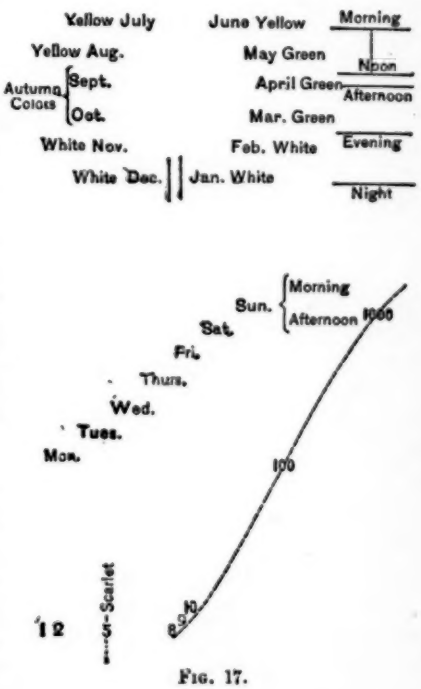


Fig. 17.

Number forms being all unlike, adequate explanation of them becomes practically impossible. Speaking very generally, however, their origin may be traced to one great cause—namely, the attempt or necessities of children to give a concrete form to the abstract. Now, numbers are among the first abstractions that children have to wrestle with. Our earliest abstract ideas, perhaps also our later ones, are, as it is now well known, either mere samples of individual things, or else a kind of composite picture of them. The child's concept of boy, girl, dog, horse, are nothing more than visual pictures of some particular boy, girl, dog, horse, or else a composite picture of a limited number of individuals. Now, numbers do not admit of such composite pictures. They are bald abstractions that the poor child must manage in some way. In most cases, if he be an eye-minded child, he merely visualizes the Arabic numeral. He may give it

individuality further by clothing it in a particular color, or even personifying it outright as in the two cases given. Color audition and association of color with written characters are explained by many as due to physiological conditions, especially to the contiguity of the cortical center involved. Dr. Krohn, in a recent review of the subject in the American Journal of Psychology, adopts this explanation in part. It is doubtful whether this hypothesis is necessary to explain the comparatively rare cases of color associations; it certainly is not necessary for explaining number forms. In any case, physiological association would be due, either in its origin or as a justification of its survival, to useful psychic associations. Now, in the matter of number forms, sup-

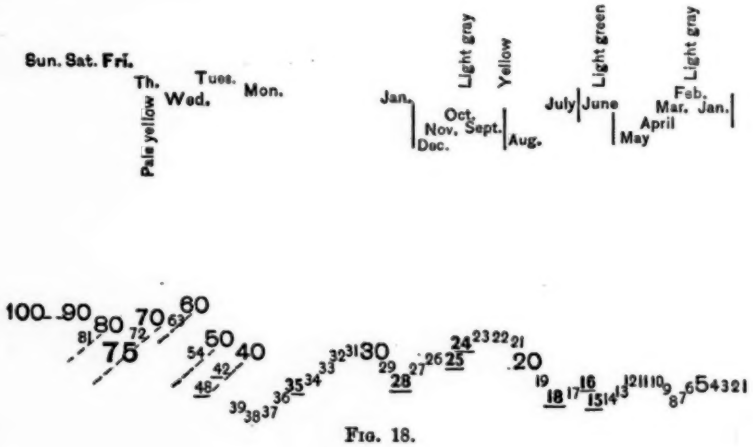


FIG. 18.

pose that the child is required, as is very early the case in counting, to think of the numbers not separately, but in relation to each other. He has then the problem of arranging abstractions in a series, and, if he is naturally an ear-minded child, will arrange them as a mere series of associated sounds. If, however, he is eye-minded, he may consciously or unconsciously hit upon the device of a visual spatial image, and thus enable himself to comprehend and remember the numbers as he does other things by a mental picture. A number form thus becomes a little system of topical mnemonics. Its continuance, either in the individual or, in cases of inherited forms, in the family, is of course due to physiological conditions. In every case, however, its origin is probably to be traced to useful psychic associations.

M. STANISLAS MEUNIER has been able to produce artificially, by a process of reflection, an appearance like that of the gemination or doubling of the canals of Mars, and suggests hypothetically that the phenomenon in question may be one of that character.

THE TREPANG.

By WILLIAM MARSHALL.

THE variety of food substances that men have obtained from the animal and vegetable kingdoms is really wonderful. One might say, "There are many men on the earth, and every one will eat what he can get the most of and at the cheapest rate, and so they have tried and tasted them all." We may grant this, but the most curious fact in the matter is, that the strangest dishes are not foods of the masses of the people, but are rather the costly dainties of the wealthy classes. Nowhere have such rare tastes in food been developed as among the Romans in ancient times and the Chinese. There may be found in the bills of fare of the latter people addled eggs, fat grubs, caterpillars, sharks' fins, rats, dogs, Indian birds' nests, and—the finest of all their delicacies—trepang. What is trepang?

Trepang or tripang is a collective name by which a considerable number of species of most curious sea animals are designated; they are also known as sea rollers, sea cucumbers, in French as *cornichons de mer*, and scientifically as holothurias. They are among the most sluggish of animals. Only the fixed or stationary animals are slower than the holothurias. They lie like gray, brown, or black leather pipes or cylinders on the bottom of the sea. One might watch them half a day long, if he had nothing better to do, and hardly see them change their position; and they rarely move more than a foot or two in several hours. Their class relatives, the other spiny-skinned animals or echinoderms, are much more active. A sea urchin or a starfish is able to get away from a spot quite nimbly, and the serpent-stars, the most active members of the whole order, are capable of using their long, slender, many-jointed arms as legs, and are as quick and alert as crabs.

FIG. 1.—SERPENT, OR BRITTLE STARFISH.

One would not suppose, at the first glance, that the sea cucumbers are relatives of the sea urchins and starfishes; for while the skin of the latter is thickly armed with scales of limestone, and they possess a radial structure that is easily distinguished, the appearance of the others is very different. The skin of most of them, including the trepang, is always leathery, compact, and closely adherent to the muscular system.

Still, the chalky deposits are not wanting in them, but they are microscopically small, are scattered, and rarely exhibit patterns or knobs. The radial structure is easy to recognize in many of them, but not in others, especially in the deep-sea forms which have only recently become known. But this is a modern variation. The ancient typical structure of all the spiny-skins is radial, and the number of rays is five or a multiple of five. When rays appear in other numerical relations (based on 1, 4, or 6), it may be traced back to a recent variation. While the mouth in the sea urchins and starfishes is on one of the broad sides of the somewhat flattened body—which for this reason is designated as the buccal, or, not very accurately, ventral region—in the sea cucumbers the body extends from the mouth to the other pole, and the animals are not flat, like their relatives, but lengthened out like worms. They, therefore, do not move on the mouth-surface. Thus they are transformed from a radial symmetrical structure into an apparently bilaterally symmetrical, right-and-left structure, but really equally lateral, and, superficially regarded, look like thick, plump worms. Around the mouth is a fringe of tentacles, shield-formed or greatly branched, which serve as organs of touch and groping, or perhaps for breathing. The size of the animals varies greatly; there are forms in the depths of the northern seas which measure but little more than a few centimetres, while tropical species living near the surface are two feet long and more. Their stupidity and slowness of motion correspond with the kind of food they live on. They fill themselves with sand and the detritus of crumbled corals; and, as they do not hunt for food, they need no eyes or organs for rapid motion. In those sediments of the sea are enough organic substances—products of decay, algæ, animals of the lowest species—to keep the slow metabolism in action by their motion. Such inert animals would soon fall a prey to the always hungry robbers of the sea if they had to depend on their skill and dexterity. But they seem to have other means of keeping their enemies away; possibly they have a bad taste to them, or their tough, leatherish skin causes them to appear undesirable morsels

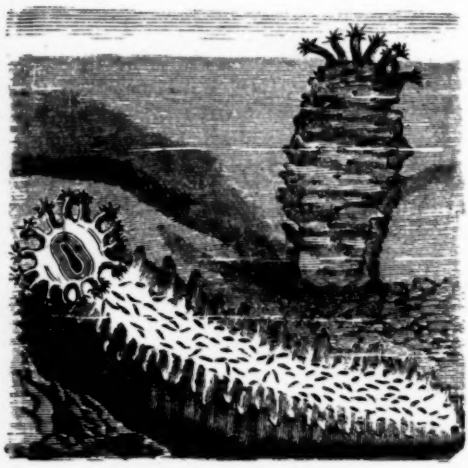


Fig. 2.—Sea Cucumber.

to their meat-hunting fellow-denizens of the sea. They have an exceedingly rare peculiarity. When one excites them, handles them roughly, or takes them out of the water, they contract their musculous body convulsively, and vomit themselves out—not only the contents of their stomach or intestines, but the intestines with the contents. But this self-mutilation, apparently so terrible, is not as bad as it seems to be. The intestine is capable of replacing itself, and, after a short season of fasting, our sea cucumber is again restored to its former condition. This is a remarkable phenomenon of a regeneration or restitution process, not yet sufficiently investigated. The holothurias are, like all the spiny-skinned animals, exclusively inhabitants of the sea; at least no fresh-water form is known. In the sea itself, however, they are of universal occurrence. Their representatives are found from pole to pole, and in all depths, from those of only a few metres to those of a thousand metres and more.

A former officer of the Dutch East Indies, M. Lion, who is thoroughly acquainted with the characteristics of that remarkable region, says that there is not an island in the Indian Archipelago near which the trepang is not found; and this is confirmed by the Englishman Jamieson, who marks as the home of the animal all the seas from Sumatra to New Guinea. The trepang can be found everywhere in this region when the surf is not too strong, chiefly at depths of from six to nine metres, on flats covered with coral sand, but not on muddy bottoms. Here they feed, as the English author Guppy has described them to us. An individual of any of the species of trepang from twelve to fifteen inches long will eat half a pound of weathered coral sand a day, loosening it from the surface of the reef. The term eat, however, is hardly the proper one. The animal lets the mass, which contains only a trifling fraction of nutritive matter, pass through its intestines. Fifteen or sixteen of these animals would thus dispose of a ton, or about eighteen cubic feet, of sand in a year. Mr. Guppy speaks of an "organic denudation," of a process of weathering of the coral reef, in course of accomplishment through living causes.

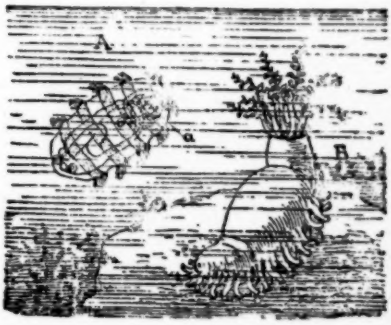


FIG. 3.—INFANCY OF A SEA CUCUMBER. A, a jelly animal swimming and feeding; *a*, small sea cucumber forming inside. B, the young sea cucumber with the leaf-like tentacles round its mouth, walking on its tube feet.

"The Celestial Empire," says Mr. Jamieson, "could not exist without trepang and East Indian birds' nests; and the inquiry for

these articles is therefore so brisk that the danger of a glut in the market can hardly be feared. Holothurias are even fished in the Bermudas and the West Indies, and exported, chiefly from Boston, to China. They are probably not sold there as products of the Atlantic ports of the New World, but mixed with real Indian trepangs. For about eighty years also trepangs caught near Ceylon and the Isle of France have been marketed in China, and have sold well; but are ranked—not being well enough prepared for the most delicate Chinese tastes—among the most inferior qualities of the Moluccan supply.

The principal trepang fishers are the Buginese and the inhabitants of the island of Goram. There go out together flotillas of from thirty to forty small, apparently fragile, but really quite seaworthy boats—called *proas* in the East Indies—with a complement of about a thousand men. The fishermen receive no wages, but are supplied with all the necessaries for the expedition—provisions, etc.—by Dutch and Chinese traders; these then have the right to the whole catch, for a previously determined price, to be paid on delivery, of which each participant in the voyage is entitled to his share. The dangers connected with such an expedition appear not to be small. But the business is a lucrative one. While we can not examine the accounts of the Malays and Chinese, we have evidence of this from another source. An American, Captain Eagleston, sent out five successive expeditions, which brought him 4,467 pikols (a pikol is 61·5 kilogrammes) of trepang, or, at 1,100 to the pikol, 4,913,700 individuals. The enterprise cost $10,337, and returned a clear profit of $67,924.

This fishing is conducted in a rather primitive manner. The most of the "fish" are caught, in shallow water, by spearing the larger ones and diving for the smaller ones; in deeper water an extremely simple drag-net is used, which is fastened to a long handle of bamboo.

A suitable number of trepang having been caught, the fishermen repair to the nearest island to put them up. The trepang are first opened and disemboweled; then the water is pressed out, and they are rubbed within and without with dry lime, which the Malays call *tsilumam*. They are next dried, either in the sun—which gives an inferior product—or in special crates, beneath which a smoking fire is kept burning; and, lastly, they are packed in bags. According to Mr. Wallace's description, they look like sausages that have been rolled in mud and dragged through a sooty chimney. The kind which I have occasionally tried at our *delicatessen* shops does not present quite so bad an appearance as that, but it is probably not one of the best qualities.

The dressed trepang are next taken to an appointed place

where a kind of fair is held at certain times. The Buginese, who are the most enterprising trepang fishers, have such a place in the little island of Kilwaru, between Ceramlaut and Gessir. It is really only a sand bank, fifty ells long and broad, rising three or four feet above the level of the sea, and surrounded by coral reefs. Other such places are situated on the Aru Islands and at different spots here and there in the Australasian Archipelago. Very many are taken to the chief mart at Macassar; and Java has recently begun to compete actively with this island for the trade.

The market price of this costly dainty depends not on the size of the individuals, but on other qualities which are mysteries to all but connoisseurs. The Chinese dealers and sorters understand them, but the native fishermen pay no attention to them. Crawford mentions thirty different qualities, the best of which, called *takker itam*, costs about eighty dollars a pikol, while the least valuable, the *kuasser*, or *peku goreng*, can be got for a little more than five dollars a pikol. A very good sort comes from the Marianne Islands, and is called *guam*.

About 1,510 pikols a year of trepangs are sent to China from the Aru Islands, 6,000 from Java, and 8,000 or 9,000 from Macassar. The whole quantity brought to the Celestial Empire every year amounts to 90,000 pikols, but the demand is always ahead of the supply; and yet the trepang is not a people's food in China; for, while the number of individual sea cucumbers consumed there annually rises to 99,000,000, the empire has 380,000,000 inhabitants; so that only every fourth Chinaman could possibly get a trepang a year. The market price in China ranges from about $23 to $135 a pikol. Averaging it at $54 a pikol, we find that the frugal Mongolian sons of heaven yearly spend nearly $9,000,000 for this sea worm.

Not being versed in Chinese cook-books, we can not give directions for serving up the trepang; but, according to Jamieson, the Chinese make strong and palatable soups and various fricassees from them.—*Translated for The Popular Science Monthly from Daheim.*

Of the influence of the recent earthquakes in northern Italy, M. Goiran has observed that they were apparently followed by a speedier germination of seeds, a more rapid growth of the young plants, a more luxuriant vegetation in the pastures, tillable lands, vineyards, and copses, and a more distinct greenness of foliage. He ascribes these results, not to the earthquakes directly, but to the augmented production of carbonic acid, a more complete distribution of fertilizing matters in the soil which suffered a sort of trituration from them, and to an increased electrical development. Under some conditions earthquakes seemed to have an unfavorable influence on vegetation, but this, M. Goiran believes, was the result of long droughts that accompanied them.

SCIENCE TEACHING.*

By Prof. FREDERICK GUTHRIE, F. R. S.

AT the outset of our inquiry into science teaching, we are, of course, met by the old question as to the purpose of education. There are those who regard education as an intellectual arming and equipment for the battle of life. Others look upon it rather as an end than as a means. The first would supply to the individual only those weapons which he is likely to require in making his way in the world. The second advise a wider, and therefore more dilute, education (the time given to education being the same), and would relegate the acquirement of specialties to the exigencies of the career. I suppose that it need scarcely be insisted on, nowadays, that both of these views are fallacious on account of their partiality. The most favorable product of the first is the "successful" specialist, who is for the most part a burden to himself. The second gives us the shallow "prig," who is for the most part a burden to his fellow-creatures.

A good citizen—and by citizen I mean, of course, a citizen of the world—must be a man of large sympathies. Though color-blind, he must have common feeling with painters, and, if tone-deaf, the works of musical composers must not be without interest to him. And through all it must not be forgotten that distinction is a noun of limited number. The time may come when they who know as much mathematics as Newton shall be counted by scores. The time has come when they who know as much geometry as "Euclid" are to be counted by thousands; and they who know as much chemistry as Dalton, by tens of thousands. But we are as badly in want of Newtons, Euclids, and Daltons as ever.

Here, as elsewhere, it appears that an apparently insuperable difficulty is half surmounted when fairly confronted. It is, without doubt, the conviction of those whose opinions of to-day will count as truisms to-morrow, that, up to a certain stage, and as far as the presenting of opportunities is concerned, the education of one should be the education of all. Liberal variations should be recognized in accordance with the tastes, and especially with the distastes, of the individual; yet there is a certain nucleus of somewhat indefinite boundary which should be offered habitually to each. When I say "somewhat indefinite," do not, I pray, imagine that I want to shirk a difficulty; on the contrary, my purpose is to accentuate and try to deal with it.

It is perhaps in matters of taste which, in their developments,

* Abridged from the Journal of the Society of Arts.

become fine arts, that the greatest eagerness to learn, and the greatest antipathy against learning, are manifested by the individual. And it is for this that I should relegate such matters to the later stages of a general education.

When, accordingly, I shall have to advocate the introduction of drawing into the very earliest stages of education, it will be understood that I am not considering it then and there as a fine art, but as a mere record of the perception of things. It is in regard to subjects which involve taste that the course should be least rigid. If the arithmetical course, for instance, were less rigid, the parent might, indeed, be spared the ignominy of having to confess to his child that he (the parent) does not know how many pennyweights there are in a kilogramme. Think how we parents have to shuffle, and how we scarcely recover our dignity after we have, more or less clandestinely, referred to books. This is bad. But, to my mind, it is far worse to have to listen to some poor little mortal trying to acquire some one or two set pieces on the piano, for hours daily, and for months yearly. And the excess of pain in the second case over that in the first is due not to the fact that our own physical agony is greater than our moral ignominy, but that in the second we see a long vista of hopeless effort before the little victim.

It is the legitimate boast of this country that the highest offices of the state, excepting of course those pertaining to the throne, are open to the child of the lowest birth or the deepest poverty. It is as certainly one of the greatest scandals of the country that such offices are open to and have often been held by persons of the very lowest culture and ability. As long as this is so, as long as a man may aspire to become, and actually become, a judge, a bishop, an ambassador, a colonial governor, and yet be and remain on the whole an ignorant fellow, so long will the educational establishments, whether schools or colleges, in which such persons have received their so-called educations, remain much as they have been.

Is it not rare to find an artist, either literary, pictorial, musical, or other, whose conversation does not bore you on account of its narrowness? Unquestionably this is so, and unquestionably the best in each profession are the first to admit it. Even in a profession such as that of medicine, where we have a right to expect to find at all events scientific culture, we find rarely anything of the kind. Owing to the fact that the medical profession has had for centuries our healths in its hand, the ignorant naturally have recourse to the doctor in matters of health; nay, are in a manner compelled to do so. Accordingly, and for instance, you find our vestrymen appointing as public analysts any kind of broken-down medical man, who does not know one end of a test

tube from the other, although he may know on which side his bread is buttered.

Even the surgeon, whose profession is eminently scientific, is too often shamefully ignorant of the very elements of chemistry, physics, and mechanics, the three general sciences which, together with the trivial science of anatomy, make up the whole of the science of his profession.

On the bench the want of scientific culture is painfully conspicuous. Speaking under correction, I suppose I may go so far as to say that, theoretically, law is founded upon justice; that it is, at all events, a more or less crude effort toward that rather illusive ideal. As a matter of fact, lawyers will tell you, with beaming countenances, that English law is an inchoate hotch-potch of enactments and precedents, obsolete, imaginary, supplementary, and contradictory. In fact, the idea of right is replaced by an indefinite number of rules of an arbitrary character. It is here to be well noted that the study of such arbitrary information—I will not call it knowledge—has and must have a narrowing influence; it deadens the mind, as it must deaden it, to the perception of principles. Now, the laws of Nature are not parliamentary enactments, and a judge, in his questions to witnesses, and in his remarks and summings-up, when scientific matters are before him, often appears at great and painful disadvantage through his efforts to codify Nature. Frequently, indeed, his remarks, as reported, are the funniest things in a daily paper. Of course, the efforts of the judge are greatly aided by counsel, who are supposed to be able to master any question in any science in twenty minutes. I am ashamed to say how justice is aided by the "scientific experts," generally of third or fourth rate standing in their professions—well, this is also an unpleasant subject. As to the final outcome of the suit, as a court generally reverses the decision of the one below, a great deal depends upon whether there is an odd or even number of courts between the first and the last. But I for one do not want either to ridicule or pity that which should be sober and majestic. And if it is not possible that every judge should have scientific training, it would be surely advisable that one or two should have it, and that causes involving scientific questions should be brought before such alone.

As it is from the universities that the so-called liberal professions are to a great extent recruited, I am bound to speak a word or two as to the position of science in them.

Of the teaching of science at the Universities of Oxford and Cambridge I need say but little. The weighty list of names illustrious in mathematics and astronomy which the latter of these can show, might be considered sufficient to redeem it from the reproach of neglect of scientific culture. But in such an estima-

tion we are justly to consider the boundlessness of the opportunities, the vastness of the means, and stringency of the duties. Regarded under this light, and in spite of many notable examples to the contrary both in the past and in the present, it does not admit of a shadow of doubt but that on the whole these opportunities have been greatly wasted, these means wrongfully applied, and these duties wantonly neglected.

These universities were primarily intended for the teaching of those branches of knowledge which have since developed into science. I imagine that education as understood for instance by the Greek was mainly athletic, scientific, æsthetic, literary, and political; literature in its widest, politics in its narrowest sense. Their philosophers looked around, as all philosophers are bound to do, as most have done excepting Kant and Comte, whose philosophy, based upon insufficient scientific knowledge, crumbles to pieces when touched. The Greek philosopher got much of his honey from abroad; but the comb he built for it was geometric, universal.

It was for the purpose of understanding such scientific writers as Aristotle, Euclid, Archimedes, that the "schools" were founded and supported. Then we have Plato, who seems to me to be forever hanging on to the hem of the garment of the Great Master. Much of this of course came through the Latin language. But shortly the means became the end. The language was found to contain a literature. Then a curious but not unnatural event happened. The means of acquiring knowledge in a foreign language degenerated—I will use no other word—into the study of that language, redeemed by the simultaneous acquirement of its marvelous literary treasures. Hence arose the dreadful school of dogmatic grammarians and pseudophilologists. Their day is passing, because grammar and philology are becoming sciences as exact at least as geology or biology.

It is, I think, hopefully to be expected that we shall soon lose sight of those dreadful creatures who used to wobble their heads over what they in their ignorance conceived to be a false quantity, often mistaking accent for quantity, partly through want of scientific training, partly through ignorance of the knowledge acquired by other nations. Such creatures were, perhaps, the natural outgrowth of the state of transition between Aristotle and Darwin, between Archimedes and Joule.

The really frightful outcome of all this was that, for a time, information took the place of knowledge; and the culture of the university was little beyond that of the cabman, the postman, or at best that of the librarian.

Perhaps the very greatest revelations made to man in the historical past took place in the last quarter of the last century and

in the first half of the present. It was then that chemistry led us to understand the composition of matter. It was then that physics developed the co-ordination of the known forces and showed the existence of a new one. It has been during this time that biology has been changed from the chaos of natural history into a hopeful cosmic science.

In the matter of chemistry, the record of what we owe to these universities is shamefully short. While the intellectual world was ringing with the discoveries of Priestley, Black, and Lavoisier, the universities were concerned with the insignificant squabbles of philologists. While Faraday and Dumas, Liebig and Darwin were at work, what was, say, Oxford doing? Future generations will scarcely credit it. The leading lights in that university had nothing better to do apparently than to issue and discuss tracts on the difference between "tweedle-dum and tweedle-dee."

And even now, in spite of many vigorous efforts and encouraging successes, in spite of the notable men who have filled and are filling the posts of teachers, the universities under consideration can not be considered as centers of science. The very best men connected with the universities are the first to admit this. For such centers those who wish to become masters of the craft have had to look abroad, or to the metropolis, or to our provinces.

In regard to the teaching of science in the most widely known of our English public schools, we must regard it as being for the most part abortive. This has, without doubt, been brought about chiefly by the narrowness of culture of the head masters and their subordinates.

In such a school the unhappy science teacher is the worst off. If he be also a teacher of classics, who undertakes to teach science by reason of some smattering of it which he may have picked up in a desultory manner, his task is distasteful to him, and we may be sure he is not slow to contaminate his scholars with such distaste. He detests his duties partly because his ignorance is a disagreeable revelation to himself, but mainly because he feels that quick-witted lads soon discover his incompetence.

If, on the other hand, a highly qualified scientific man is employed, he finds himself out of sympathy, almost out of touch, with the rest of the school. The absolute necessities for teaching his science are denied to him or grudgingly dribbled out. His colleagues regard him without any feeling of comradeship, and so again the boys get to look on him as a sort of pariah, and on his occupation with contempt.

Observe the vicious circle. With ignorances and prejudices such as those I have mentioned the scholars from such schools go

up to the universities, and give to them in the main their own uncultured tone. As it is from the universities that public schoolmasters are for the most part drawn, the bar to improvement seems strong indeed. One obvious way to break this vicious circle lies, it is true, at hand. I can not consider it conveniently here, and I am loath to touch upon it. But this much must be said: it can not be for the welfare of any religious body that its highest offices should be filled as often as they are from a class—the class of head masters—which persistently and almost professionally sets its face against natural knowledge. For it is thus a premium is placed on one-sided and therefore imperfect culture at the very fountain-head of education. Still more rarely can it be for the advantage of a public school to be under the guidance of a member of a class which has, speaking generally, consistently shown both fear and dislike of Nature and her interpreters. Whatever hope there may be in the future for relief in this matter, it is probable that such relief will rather be effected from the outside than from the inside.

As to this influence from the outside, where shall we look for it? Clearly in the aspirations, ambitions, and discontents of the better classes. The better classes are the more intelligent classes, and these are, without any doubt whatever, formed from the ranks of the artisan or handicraftsman—whether of our cities or our fields—and especially from the ranks of those who have been artisans or handicraftsmen, but whose ability has advanced them, say, from the laborer to the farmer, from the carpenter to the builder, from the nail-maker to the engineer, from the apprentice on a barge to the captain of a "liner." It is here or hereabouts that the very marrow of our nation lies. The aspirations of these classes are opposed directly and indirectly by the more ignorant classes both above and below them. The dangerous classes are the idle classes of all ranks. He would do a far greater service to the commonwealth who should give useful employment to the idle rich than he who should sweep away a thousand slums.

It is disastrous folly to fight against the inevitable. Science will take, and is taking, its proper place in our system of education. Men may bury themselves in the darkest crypts of ignorance; they may raise the densest smoke of prejudice or spread most diligently their little umbrellas of effeminacy, and fancy they have shut out the sun from the whole earth. The contest, if contest it can be called, which is waged against science, consists of hysterical vituperation on the one hand, and mainly pity on the other. Such a contest is only of passing interest, for the issue admits of no doubt. On the side of our opponents there are, it is true, the prejudices and ignorances of the half-cultured; but on the other there is the whole universe. They who oppose the in-

troduction of science into even elementary schools do so at their proper peril and that of the commonwealth.

Having discussed briefly the positions which science has held, is holding, and should hold in general education, I shall now consider what I conceive to be the proper way of introducing the child to a knowledge of the material world. In a little book which I published some years ago, called The First Book of Knowledge, I drew up a systematic course of object lessons of the kind which I should like to see generally adopted, because I think that, however defective it may be in many respects, it is perhaps the first attempt to direct this kind of education; and I insist that, on this account, it or its method will have to be considered by educationalists. For, after all, it must be conceded that matter, and the properties of matter, play a not unimportant part in the universe in which we happen—at the present moment at least—to be living. And so my task will consist mainly in considering the purpose and use of such a book.

In the first place, it should not be a book of reference; it should not be written and used on the principle of a directory or of a dictionary, or even of a manual of household recipes, which we consult to-day to find out how to make egg sauce; and to-morrow, how to remove ink stains from the fingers.

It must be progressive in order to be educational; it must deal with familiar stuffs and things in such a fashion, and after such an order, that the understanding of one may help in the understanding of those afterward to be considered.

On the table before you is a series of familiar "stuffs and things." The total cost, including the packing box and bottles, may be three or four pounds. This collection was made to illustrate the book of which I have spoken, and it contains, I believe, all the stuffs and things required in the building of a house and used by its indweller.

Now let us build the house. The first stuff is concrete. This is made of lime and pebbles or gravel. To make lime, again, limestone or chalk is required. And to quicken or burn either, fuel is necessary. I find it therefore convenient to describe the formation of coal, and to defer the description of the formation of wood and the growth of plants, and also of the process of combustion, to a later chapter.

After coal, the description of the formation of coke, ashes, cinders, and breeze follows at once; but the complete description of the manufacture of coke is deferred until that of gas is considered.

The pupil is now prepared to understand the action of fire on limestone—the quenching or slacking of quicklime, and the formation of concrete and mortar. A description of the natural forma-

tion of clay is followed by an account of the manufacture of bricks, tiles, drain pipes, chimney pots, etc. Slate finds its proper place hereabouts.

Such stuffs as marble, granite, sandstone, and plaster (stucco) may be now described.

The chief metals used in house construction or in house furniture are iron, lead, zinc, copper, tin, and mercury, and their derivatives, such as brass, zinc plate, tin plate, and so on. And, perhaps, the only stuffs still demanding consideration are glass, glue, whitewash, litharge, and putty.

Now, all these stuffs should not only be seen, they should be handled by the pupils, and such processes as the slacking of lime, the setting of mortar and of plaster, the baking of clay, and the reduction of some of the metals from their ores, should be shown, as can easily be done by means of the materials and a few pieces of apparatus before you.

It is thus seen that I adopt the plan, which I think is the soundest one, of not attempting to generalize or philosophize until the child has got something to generalize from. But such generalization must not be delayed too long; for it is of incalculable help to the pupil in his further studies.

Accordingly, I would here or hereabouts introduce him to that truly awful revelation that there are on the earth, as far as we can search; in the earth, as far as we can dig; ay, and throughout the universe as far as we can see, but a limited number of prime stuffs—the elements. To my mind two men are in no sense on the same intellectual level whereof the one can and the other can not tell you of what elements familiar things consist. The latter may be intelligent, possibly he is well-meaning; intellectually he is a savage. Such savages abound in all strata of our commonwealth. Such savages are dangerous. We must not kill them; we are not even permitted to teach them. Let us at least catch and civilize their children, both for their own sakes and ours.

The conception of the elements leads at once to air and that type of chemical uniting called burning. Much time spent in a careful study of fire, flame, and water would be well spent indeed. Practically, and returning to our scheme, I find it far best for educational purposes to secure such generalization at about this point. The pupil can now understand something about wood, the last of the stuffs considered in the building of a house.

Such knowledge brings us at once to the heating and lighting of the house, and so to the manufacture of charcoal, the formation of peat, and the making of coal gas. The methods of obtaining a light lead to the interesting and instructive subject of matches, and the stuffs of which they are made.

Our next chapter might properly include the finishing and

furnishing of the house. By finishing I mean such processes as papering, painting, glazing, and varnishing. Furnishing would embrace the origin and manufacture of cotton thread, flax, linen, hemp, canvas, cane, wool, carpets, oilcloth, cocoanut fiber, mirrors, German silver, silver; the processes of lacquering, plating, and the manufacture of pottery, porcelain, and earthenware.

The next division would concern the person, and would include chapters on clothing, food, washing, writing, and reading.

In clothing would have to be described the textile fabrics, skins, tanning, with such adjuncts as pins, needles, combs, and brushes.

Concerning food I should be inclined to confine the instruction to such things as the five B's of food—bread, butter, beef, beer, and bacon—and such as milk, cheese, eggs.

The description of the manufacture of bread should be in a manner an intellectual epic poem. The growing of the wheat, its thrashing, winnowing, grinding, bolting; the nature and effect of yeast; the effect of baking; the relationship between the constituents of the wheat and the body. All this, I say, constitutes an epic of infinitely greater beauty, strength, and significance than can be furnished by the sulks of Achilles, the wanderings of the pious Æneas (I wish he had been drowned), the tortures of the Inferno, the ravings of Orlando, the childish imagery of Milton, or the dreary paraphrase of Klopstock.

The epic of bread is, and must be, as far above the epic of the poet as is the mere external beauty of a living flower above that of the most elaborate and gorgeous design on the back of a playing card. And I suppose the study of the construction and life of the flower is more elevating than the most subtle game of whist which was ever played.

In the matter of food, again, we have to guard carefully against the dogmatism of the smatterers who talk so glibly of flesh-formers, fat-formers, bone-formers, and so on, as though you had only to eat fat in order to become fat; bone, to become bony; flesh, to become muscular. There are people whom one may, without offense, call the "prigs" of this particular branch of science, who fancy that Liebig's extract of meat, for instance, is concentrated meat, and that a few grains of it are of the same nutritive value as an ounce of meat. This, I need scarcely say, was not the view of the illustrious author of the extract. He justly looked upon it as a condiment or stimulant. There are those who, by quoting chemical formulæ, would fondly persuade us that there is as much nourishment in an egg as in a chop. I need scarcely say I do not believe them, for I don't suppose you do. Such people compare the analysis of grain with that of the human body, and tell us to eat pumpernickel, or rye bread, or brown bread, or whole-meal bread, or white bread, according to

their schools. In order to be consistent they should recommend cannibalism, and preach that—

"The proper nourishment of man is man."

The people of whom I am speaking usually write to the papers. One shows how the condition of the workingman may be made one of affluence and comfort by living chiefly on dandelions, nettles, and sorrel (with perhaps a pinch of pepper). Another shows how the weight of a pound of steak may be doubled by cutting it up fine and stewing it with sixteen ounces of water. A third demonstrates how essential to the human frame is a certain amount of lime, and deplores the wastefulness of throwing away the shells of oysters, lobsters, and eggs. Yet another, of a more synthetic turn of mind, is familiar with heat-producers and flesh-formers, with carbon, nitrogen, and phosphorus compounds. His knowledge of chemistry enables him to recommend a cheap dish consisting of charcoal, saltpeter, tallow, and glue, flavored with singed feathers and stirred up with a few matches.

I need not apologize for speaking at some length on this subject. Food is as important to the human being as fuel is to the steam engine. It was once made a subject of reproach or banter against our nation that we had a hundred religions and only one sauce, while the nation of our critic had only one religion and a hundred sauces. I suppose if this epigram were fairly analyzed it might be found to be based upon the fact that our meats had a hundred different flavors, and our hundred religions only one; while the one religion of our critic's countrymen had a hundred different flavors and their hundred meats a single one. For I need not remind you that when and where the cooking has become most elaborate the feeding is at its worst; for, instead of depending upon the exquisite flavors of the simply cooked constituents of a meal, a sort of "Ur-wurst," or universal sausage, containing a thousand flavors, and therefore none, is the result. As good wine needs no bush, so good food needs little cookery and less sauce.

In the next place should be considered materials used in cleaning, such as soap, soda, hearthstone, sponge, vitriol, emery. And finally the materials used in writing and in books—the manufacture of paper and of pens, of inks, of pencils, of type, and the rest.

I can not but think that some such system as I have laid before you will be—will have to be—introduced into elementary education, into the education of our school boards. Not only that the lads on leaving school may be more useful citizens, but that they may have that knowledge which alone gives happiness, and which never turns to bitterness, or proves to be vain, the knowledge of the ways and the beauties of almighty Nature.

SERVILITY IN DRESS.

By HERBERT MAXWELL.

THE further we travel from the origin of our species the less concern does male humanity show to enhance what share of beauty it may lay claim to, or to screen the ugliness it is generally heir to, by grace of garments. Among civilized and well-to-do men, gala costume has no keynote now but respectability—at weddings as at funerals, at garden parties as in Parliament, costume is attuned to harmonize with the hurtful cylinder of sable which the supineness of our great-grandfathers allowed the hatters to impose on them as a headdress, and a hundred hopeless years have but served to bind more tightly on our aching brows. If the chimney-pot hat were comfortable wear—were it sunproof or rainproof, or easily carried when not in use—our allegiance to it might be monotonous, but at least it would be intelligible. But, in plain sooth, it is intolerable in sunshine; it is so sensitive of rain-drops that an umbrella must be carried for its special shelter; and when we travel, it is as difficult to dispose of as a murdered corpse. It can not be concealed; the accursed thing will fit in with no other portion of our raiment, and must be provided with a special case of grotesque and impracticable shape. In wear or out of wear, we can not forget its existence nor neglect to make provision for its protection. Cephalalgic humanity has tried every means to be quit of it, but in vain. The creature has not even a serious name, for no one, except the fiend who frames it, knows it as a silk hat; schoolboys, with the contempt born of familiarity, call it a "buster" or a "topper"; soldiers, scornfully, a "stovepipe"; civilians, realistically, a "chimney-pot." In vain has bountiful Nature provided straw, and human ingenuity fashioned felt: two more perfect substances for head-covering could not have been devised; but, perversely, littering our horses with the one, and roofing our barns with the other, we thrust our thinking organs into unyielding towers of pasteboard. In a simpler age we should have made a god of It—prayed to It, sung to It, bowed to It, propitiated It; but, having adopted monotheism, we are outwardly consistent, and are content to insist on taking it to church with us. The first inhabitant of Mars who visits the earth, and publishes a volume of travels on his return, will probably describe how, in western Europe, the possession of a chimney-pot hat is held to be essential to salvation.

And now let us dismiss the Hat from consideration (would that it could be as easily dismissed from wear!) with a passing speculation as to the tenacity with which, in its present form,

it has fixed itself in our scheme of costume. This probably has its origin in the jealousy felt by those under middle height toward others of more commanding stature. The desire to level humanity down to one standard has undoubtedly given rise to many of our fashions. A small man may *look* no bigger with a tall hat on, but he *feels* so. A hat which adds four inches to the height of each of two men—one, A, being five feet high, the other, B, being six feet high—reduces the advantage possessed by B. For although he will still be twelve inches taller than A, A will no longer be shorter than B by one fifth of his (A's) own height, for 64 inches is to 76 as 16 to 19, whereas 60 inches is to 72 only as 15 to 18. £999 is much nearer £1,000 than £9 is to £10, though between each pair there is the same difference of 20*s*. So it looks as if in this matter of hats the small men are the chief culprits.

The same jealousy of superior physical advantage has brought about many of our ugliest fashions. Sculptors and painters sigh with vain *Weltschmer* for the small-clothes of eighteenth-century Macaronis and the trunk-hose of the Elizabethans, but so long as some men continue to be born with spindle or crooked shanks and doubtful ankles, so long will well-turned limbs be doomed to the obscurity of trousers. The excuse that trousers are more convenient and comfortable than breeches and hose is groundless and insincere.

In like degree, as graceful shapes have ceased to be sought for in designing men's garments, beauty of color has also been rejected, and a preference shown for black, white, or neutral tints. In no article of clothing is this more rigidly prescribed than in leg covering; and this is the more remarkable because the word "breeches" is supposed to be derived through the Roman form *braccæ*, from the Celtic *breac*, which means variegated, of many colors. This marked preference for somber hues arises, in part, from the same desire to neutralize the effect of physical superiority which has spoiled the shape of modern clothes.

It is part of the same plan which, as is well known to ethnographers, takes the form of tooth-breaking among primitive people in different parts of the world. Just as an influential Batoka of East Africa, or a Penong of Burmah, whose teeth happened to be defective, feels happier when he has persuaded other young men of his tribe to deface their faultless ivory; so a European grandee, of bilious or dyspeptic habit, would look with prejudice on one whose clear complexion and ruddy cheeks gained brilliancy by contrast with pale-blue satin or carnatiôn silk; he might at least have the sense to eschew such combinations in his own attire, and, by showing preference for somber tints, tend, in virtue of his position and influence, to set the fashion flowing that way.

It is difficult to decide whether the gradual suppression of

magnificence in male attire and the development of feminine finery among civilized races, is more interesting to the zoölogist, the anthropologist, or the moral philosopher.

To the first of these it is a perplexing departure from the scheme of Nature, where it is a rule that any marked difference between the sexes confers greater splendor upon the male. The peacock and peahen, the lion and lioness, the stag and the hind, are common examples of a principle which, among the higher animals, finds its only exception among certain falcons.

As for our moral philosopher, his opinion does not count for much in matters of dress, or its substitute—tattooing. He probably wears a shocking bad hat, with marks of ancient rain-drops, which, like those on the Corncockle flags in the New Red Sandstone, having once been allowed to dry, are practically indelible. His umbrella is robust enough to shelter three abreast, but, honest man, he had left it in the stand at the British Museum, or his mind was too busy with a complicated train of thought to allow him to put it up at the right moment. His theory of feminine dress finds no favor with the wife of his bosom or his daughters; they bewilder him by the mutability of their fashions, for no sooner has he found a parallel in dress-improvers to the worship of Venus Callipyge, than lo! they have melted away, and an unaccountable protuberance appears somewhere else. He prepares unanswerable arguments against the cruelty of adorning hats with feathers and the bodies of little birds, but, before he can produce them, ribbons and flowers are all the mode.

Perhaps women devote themselves to the details of millinery all the more because we men have allotted to them more than a fair share of the dull things of this life. We have left them comparatively little on which they can occupy themselves agreeably. They have books, of course, but books only serve as a whet to active employment. The daily round of household duties, the weekly discharge of bills, the tedious routine of morning calls, visitation of the sick—everything, in short, that bores a man is cast upon his wife; no wonder if her thoughts attach themselves to matters of toilet, which we despise as being beneath our dignity. And thereby we, who are the oppressors, derive unmerited advantage, for we are free to feast our eyes on the pretty things in which the fair sex go pranked.

Not that our enjoyment is without alloy. Feminine costume is subject to the most sudden and excruciating variations. No sooner have we learned to delight in a simple, becoming fashion, than instantly the Evil One, whose dwelling-place is in Paris, contrives some mock deformity, and every woman of spirit hastens to adopt it. There is nothing in the human frame more pleasing to the eye than the sweet lines of a woman's shoulder; yet this is

precisely the part which, during the last year or two, the malice of *modistes* has concealed with every ingenuity of structure. Vertical humps have been placed there, contrived so as to make the chest look as narrow, the shoulders as high, and the neck as short as possible.

The serious part of this is, that the immense cost of women's dress leaves nothing of value behind it. Sables are positively the only purchase that can be looked on as a safe investment. The most thoughtful selection and design of other materials is sure to be soon stultified by the imperious caprice of Monsieur Worth. By no means can the sorrowful folly of this thralldom be brought home to one more forcibly than by a visit to the cases in the British Museum, containing the little funebral figures from the tombs of Tanagra. The exquisite grace of raiment, the delicate hair-dressing, varied to suit each different cast of features, the care with which beauty of form is accentuated instead of being wrapped up or distorted—all convince one of the cruelty of the modern system which robs our eyes of legitimate delight. How would it be with us were it the custom to lay in the tombs of our departed ones little statuettes, representing them in their best clothes? Should we not shrink from the criticism of posterity? It must be confessed that women would stand this ordeal better than men: still, a modern ball-dress, with corsage cutting horizontally across the bust, is a terrible violation of the natural lines of the figure, especially when, by means of long stays, the cincture is thrust away down where no sculptor would dream of placing it. In the name of common honesty, whence comes the mock delicacy of forbidding the form of a woman's legs to be seen? Are they more suggestive of unlawful thoughts than arms and shoulders? Shall Diana be accounted less than chaste because her statue in the Vatican shows her with tunic girt well above her bare knees? The Spartan virgins were not the less reverently regarded because the graceful *chiton*, being open on one side to allow freedom of movement, flew open as they walked, and got them the name of φαινομηρίδες. It is utterly unjust that, because some women have indifferent legs, all should be compelled to wear long skirts on all occasions. If it is desired to see which is most becoming, compare an Ayrshire dairymaid in work-a-day attire of short pleated petticoat and the linen jacket called a bedgown, snooded hair, woolen hose, and serviceable shoes, with the same girl figged out on Sunday with a flyaway bonnet on her head, a travesty of Paris fashions on her back, trailing skirts, and high-heeled Balmorals. Of the two, the first is not only the more pleasing, but infinitely the more modest in appearance.

Marie Bashkirtseff, in composing the most self-conscious journal ever penned, was in the habit of subjecting her own actions

and those of others to frank analysis. She came to the conclusion that the sentiment of physical modesty was one arising from a sense of one's own imperfection; that if one could be quite conscious of perfect proportion and beauty, there would cease to be any motive or impulse to conceal the body and limbs. Perhaps it is as well that misgivings on this point are pretty universal; but, seeing that it is fixed by an utterly arbitrary rule what portions of the body may be displayed and what may be concealed, it may be permitted to enter a protest against the tyranny which forbids one young lady to show her ankles because another one finds it expedient to conceal hers.

One longs for redemption from the barbarities of feminine fashions. One sighs to exchange the long, wasp-like waists and tight-lacing for the simple, easy gowns of our grandmothers, to replace the girdle where the Grecian zone was bound, just clear of the ribs. But one has an uneasy foreboding that the simplicity of classical toilets might be interfered with by the diabolical devices of milliners. At the close of last century, before small waists came, in the inscrutable movement of the female mind, to be counted a beauty, there was an atrocious fashion of wearing pads below the girdle, so that the drapery should fall in unbroken sweep from the bosom to the ground. Many were the shafts aimed by ribald writers against this extraordinary device; many the unjust imputations to which it gave rise:

> "Some say Nature's rights 'tis invading
> This sham swelling garb to put on:
> For how, with these false bills of lading,
> Can ships by their rigging be known?"

It passed away, and the last ninety years have seen the beginning and end of many other modes more unsightly and not less absurd. Is it hoping too much that, seeing how fast the fashions fly, all the ludicrous, hideous, and hurtful ones will, in the fullness of time, have been discarded, and a return be made to the only faultless model the world has ever seen?—*Abridged from an article entitled Clothes in Blackwood's Magazine.*

RÉAUMUR is quoted as having written, in 1720, of Bernard Palissy, the potter and one of the procreators of geology, that "it was a hundred and fifty years ago that a French author who seemed to glory in his ignorance of Latin and Greek pointed out a large number of places in the kingdom where shells are buried. I mean Bernard Palissy, all of whose ideas I would not adopt, but whose spirit of observation and clearness of style I admire extremely. I am little concerned about his lack of literary knowledge, but I can not repress a regret that he had to make pots and follow the art of *faïence* to make a living for himself and his family." Réaumur, says a French journal, would be consoled if he knew the price the pots he despised so heartily would bring now.

PREHISTORIC TREPANNING.

ONE of the most remarkable revelations made of late years by prehistoric archæology relative to primitive man has been that of the extent to which trepanning was practiced by the men of the polished stone age—the men who erected the rude stone monuments of which Stonehenge and Carnac are the highest expressions.

In 1872 Dr. Prunières first called attention to the fact that among the interments of the neolithic age in the limestone caverns of Lozère, and under the so-called dolmens, a certain number of skulls found had been surgically treated. Portions of the skull had been removed, in many cases during life; whereas others had been trepanned after death. There could be no question but that in many cases those who had been operated upon had survived the operation, as the reparative efforts of Nature were marked.

The matter was taken up by Dr. Broca, who published an essay on the subject, which he had communicated to the Anthropological Congress at Buda-Pesth in 1876. It has since been investigated by M. Nadaillac, and has been recently referred to by Count d'Alviella in his Hibbert Lectures for 1891.

A word first upon the race which practiced trepanning. As far as can be ascertained, it entered Europe by the shores of the Baltic from the Caucasus and Crimea, strewing the plains of Pomerania, Hanover, and Gröningen with their monuments, erected out of the stones left by the rafts of ice that floated over these submerged plains in the Glacial period. This race occupied Denmark and Sweden, crossed into Great Britain, and has left its remains in Scotland, Ireland, Wales, the west of England, Dorset, Wiltshire, and Kent. It entered France, made Brittany its stronghold, traced up the rivers to the central plateau of France, but never occupied the upper waters of the Elbe, the Rhine, or the Meuse, was never on the Danube at all, and, though it descended from the central mountains of France to the Rhone, yet never advanced far east beyond it. On the other hand, it crossed the Pyrenees, erected its rude stone monuments in Spain and Portugal, traversed the strait of Gibraltar, and, after setting up some circles and cromlechs in northern Africa, disappeared altogether.

What this race was we do not know; it was not a pure one, for among the skulls found in its sepulchral monuments some are round and some are long-headed; but in all probability it was a long-headed race that had subjected other peoples, and had brought along with it wives and slaves of alien blood.

The tools and weapons of this remarkable people are of beau-

tifully polished flint, chert, and jade. In the possession of the writer is a granite axe-head from a dolmen in the center of France, on which great pains have been spent to give it a polish. Some of the flint spear-heads worked by them are marvels of labor and ingenuity. A large core of flint has been taken, and out of it a flake has been got which has been not only worked into a flame or tonguelike shape, but has been diagonally grooved throughout on one side for ornamental purposes. One such, over a foot in length, of milk-white translucent flint, was found in a dolmen on the Lot a few years ago. It was scooped out with forty diagonal spiral lines. The labor expended upon it is incredible. This race was acquainted with pottery. It did not burn its dead at first, but very frequently scraped the flesh off the bones before consigning the remains to the sepulchre. The bones preserve the scratches made by the flint scrapers, and they are not always correctly placed to form the skeleton in its tomb, a left arm being sometimes put to a right shoulder; and sometimes important bones are missing. After a while bronze became known to the race of the megalithic monuments. It was introduced from the south; it seems to have traveled up the basin of the Po.

In 1880 the Baron de Baye published the results of some remarkable discoveries made by him in the chalk of the Marne. Here he discovered a number of caves sealed up, and completely untouched, that had been the sepulchres of men of the polished stone age. There was much about them that was extraordinary; one feature was a rude representation of a woman, always on the left side of the entrance into the sepulchral chamber. Along with this woman was figured, carved in the chalk, a flint hatchet; color had been applied to distinguish the flint stone from the horn handle into which it was fixed. In these mortuary caves a great number of remains of human beings was found. Some of the caverns were clearly family sepulchres. Some contained a large number of dead who had obviously been killed in a battle. But what specially concerns us now is the fact that, among the skulls recovered from these caves, a certain number showed that they had been trepanned, precisely as had been the skulls obtained by Dr. Prunières from the caves and dolmens of Lozère. Not only so, but the dolmens of Algeria have given up skulls treated in like manner, so have some found in Denmark. Obviously the very unpleasant custom of cutting slices out of the skulls of some of their members was continued in this race from their first appearance in Europe to their final disappearance in Africa.

M. Cartailhac, in his La France préhistorique, says: "A considerable number of our sepulchres contain perforated human skulls. The openings, without being geometrical in shape, are sufficiently regular; they approach more or less the shape of an

ellipse, in length about 1⅝ inch; the sides are gradually reduced in thickness, and are always cut obliquely, at the expense of the outer surface of the bone."

These holes cut in the head occupy different positions; some are at the side, some on the top of the head, but never on the brow or any portion not covered with hair. It is quite impossible to suppose that they have been due to a blow of an axe or sword. That would only be possible where portions of the skull were arched or projecting. Moreover, a blow would have left bruises on the bone, and it must be remembered that steel weapons were then unknown; no flint or bronze axe or sword could make so clean a cut. Besides, an examination of the edges of the wounds reveals the manner in which the trepanning was effected. There remain the scratches, formed by a slip of the tool employed, and the marks of the flint scraper which effected the operation. In the majority of cases the skull was mutilated during life, and it was carried out with such skill as not to injure vitality. Some of the operations took place in childhood, and those who had been trepanned grew to be men and women.

The tool employed seems to have been invariably a flint scraper, with a sharp edge, which was worked round and round the portion of the skull that was to be removed till the bone was cut through, when the disk was taken out whole. It was necessarily a laborious and lengthy process; it could not possibly have taken less than an hour. In the case of children, when the skull is tender, it would, of course, take very much less time.

The first of the trepanned skulls was discovered as early as 1685 in the tomb of Cocherel. Montfaucon mentions it. He says, "One of the heads there found had the skull pierced in two places, and apparently both wounds had healed." A second specimen was found in 1816 in a cave at Nogent-les-Vierges which contained two hundred skeletons. "One of the skulls had in it a great hole three inches long and two inches wide, which seems to have been caused by a wound which had resulted in the loss of a large piece of bone. Nature had repaired the edges of the fracture, and M. Cuvier thinks that the man in question may have lived a dozen years after having received it." Thus this discovery was described at the time and misunderstood. It was not till Dr. Prunières drew attention to the frequency of skulls being thus marked and mutilated that the importance of the matter was realized.

In the Ribeiro Museum at Lisbon is a skull of the neolithic age that shows on it the work of the operator left unfinished; the oval has been nearly, not quite, cut through. In the Musée Broca of the Société d'Anthropologie is a skull from Oise, of a man who apparently died under operation. Other skulls are indeed found that have been submitted to the saw. One was dug

up in the valley of the Petit-Morin with the whole top of the head removed, but these belong to an entirely different category. They are all cases of mutilation after death—mutilation, in all probability, of the heads of enemies.

One of the skulls found by the Baron de Baye was that of a man of advanced age who had been trepanned twice at different periods, and had recovered from both operations.

But this is not all. Not only were skulls of living men systematically trepanned among the men who raised the rude stone circles and dolmens, or, as we call them, cromlechs, but they preserved and used as ornaments or amulets the pieces of skull thus removed. A great number of such cranial disks, pierced with one or two holes for suspension, have also been found in their sepulchres, and these are not infrequently polished or rubbed by fine long usage.

It does not appear that this strange custom of removing portions of the skulls of living men and women was confined to the men. Skulls similarly treated have been found elsewhere. If it were a fashion, it spread among other races.

One portion of a skull bored with holes for suspension was found in a tumulus in Thuringia belonging to the bronze age. A trepanned skull was extracted from a covered stone avenue at Borreby, in Denmark; another from a dolmen at Näs, in the isle of Falster; another comes from Karleby, in West Gothland, from a tomb of the transition period from polished stone to bronze, and this, so far, is the sole example from Sweden.

But prehistoric trepanning was practiced in America. In the Peabody Museum is a skull thus treated. Another comes from Peru. A mound on the Devil's River furnished another example. More trepanned skulls have been found near Lake Huron and Grape Mound. A skull in a great tumulus on the river Detroit had two holes cut in it. A sepulchre at Chaclocayo, near Lima, contained a head that had undergone like treatment. A trepanned skull was found in a tomb in the upper basin of the Amazon. But all the American cases are of cranial mutilation after death.

To come to Europe, in addition to those trepanned skulls already mentioned in Sweden, Denmark, and France, they have been found in tombs of the neolithic age in Portugal and in Spain.

Dr. Boulongue, in his work on Montenegro, says that it is a custom of the natives of the Black Mountain to have portions of their skulls removed for the smallest motive, merely if troubled with headache, and not at all solely because of a blow and breakage of the skull and concussion of the brain. He says that he knew of individuals who had themselves trepanned seven or eight times without its affecting their health.

Apparently in all these cases the persons who were trepanned walked about among their fellows with always a soft place in their heads. But sound skulls have also been found with disks from other men's heads securely lodged within their own. These disks must have been introduced after death, and must have had a religious purpose.

The first of those so discovered was in the museum of Grenoble; it was noted in 1867 by M. Chambre, who completely misunderstood it, and supposed that the disk was a sort of bone spoon.

Another very singular discovery among the sepulchral remains of the same epoch and race concerns skulls, though not the trepanning of them. A considerable number of heads have been discovered stuffed with children's bones, and bearing traces of having been polished by friction. The skulls have apparently been carried hung round the neck as a sort of pocket on the breast, and small bones belonging to several children have been packed within them, specimen bones, as it were, taken from several different subjects.

The explanation of this is much easier than that of the trepanned skulls. It is supposed that a widow carried about with her the head of the "late lamented," and that in it she preserved memorials of her children who had died young, for the purpose of keeping by her a couple of bones of each of her pets.

The practice of wearing disks of skull was not confined to the people of the stone age. Two such have been found with holes for suspension in a Gaulish sepulchre at Wargemoulin, in Champagne, suspended to a bronze torque. Another was found with the body of a child of the Gaulish epoch. Others have been found in the cemeteries of Marne appertaining to the same people and to the historic period. In some cases undoubtedly heads were operated upon after death, and portions removed to serve as trophies, much as a North American Indian carried off and gloried in the scalps he obtained. But the evidence is all against this as explaining the greater number of cases of holed heads.

What is more probable is that these cranial disks were employed as amulets. In the exhibition at Milan in 1881, M. Bellucci showed such a portion of a skull that had been actually in use at the present day among the Italian peasantry as a cure for convulsions and epilepsy.

The writer of this article remembers some forty years ago making the acquaintance of a very charming Irish gentleman and lady. One day she thought she observed that his eyes were resting inquiringly on her brooch, which was of gold, inclosing a mass of fractured bone. She laughed and said: "Are you admiring my brooch? I will tell you the story of it. One day, some

ten years ago, when I was a young girl, I was staying in the house of a friend who also knew Mr. N., who is now my husband. We were having a game—a romp—and running after each other through the house, which was large, with long galleries and chambers communicating with one another. Mr. N. was close behind me, trying to catch me. I darted through a door and threw the door back behind me. Mr. N. had his head down, and the handle struck his skull and he fell stunned. The skull was fractured, and to save his life he was obliged to have it trepanned. Now he wears a plate of silver over the hole, and I wear the portion cut out of his skull in this brooch. The accident—I suppose my distress and remorse—brought about a *rapprochement*; we became engaged, and are now man and wife."

So the custom of wearing cranial disks need not be regarded as completely done away with, even in our days.

Various explanations have been offered to account for the trepanning of the skulls of the neolithic men; but perhaps, before considering them, it will be as well to notice another series of phenomena, and that connected with the sepulchres of the same people, as it belongs apparently to the same category. This is the perforation of the tombs themselves. It has been observed repeatedly that among the dolmens, covered avenues, and kistvaens of this race there is very generally one stone that has been trepanned—had a hole cut through it; not only so, but that in their circles of stones one gap has been almost invariably left so as to make the circle incomplete. Trevethy Quoit, in Cornwall, has a rectangular hole cut through the cap-stone. La Maison des Fées, at Grammont, in Hérault, has the stone at the head perforated. At Conflans was one of these monuments with not only a round hole in the closing stone at the foot, but also the plug wherewith the hole could at will be closed. It has been moved to the Musée St.-Germain. In the Crimea and in the Caucasus, where the same kind of monuments is found, the hole in one side, laboriously bored through one slab, is a constant feature.

We may, and probably ought to, connect the holed stones in tombs with the holes in the skulls. And the most probable explanation of both is that they were intended as openings whereby the spirits might escape, and trepanning was employed on those who suffered from epilepsy, which was regarded as possession by an evil spirit. Broca says: "The art of trepanning was applied to certain spontaneous maladies, and followed the opinion formed of affections of the head in nervous disorders, as idiocy, convulsions, insanity, epilepsy. Maladies which science regards as natural struck the imagination of the ignorant, and they attributed them to divine causes, to demons, to possession. Who can say that trepanning, now a practice almost abandoned, was not em-

ployed among the first men as a means of letting demons escape out of the system, by opening for them a door of exit?"

"I ask," says Broca again, "for what motive these operations were performed, not always, indeed, but usually, on young subjects, often on mere children; and I venture to suggest that they were due to some superstition, and formed part of a ceremony of initiation into some sort of priesthood. This would, indeed, suppose that there existed a sacerdotal caste among the neolithic people, and there can be little doubt that they did possess an organized form of worship. The cranial disk inserted in a skull after death, what can it mean but some vague belief in another life? If it be objected that the cranial mutilations were too grave to be accepted as a religious ceremony, I answer that trepanning is not in itself a very dangerous operation. If it is so often attended by fatal results nowadays, it is because recourse is had to it only in desperate cases. What produces death in so many instances where trepanning is resorted to, is not the trepanning, but the cerebral congestion which one endeavors to relieve by the operation. Besides, religious exaltation knows no limits. If certain divinities were ready to accept a scrap of skull in place of an entire human victim, they may have passed as remarkably indulgent. It is well known that among the negroes of western Africa some individuals will disembowel themselves as an initiation into sanctity, or to prove the efficacy of certain charms. Some of these men perish, but others recover, and such become saints among their tribe."

We are disposed rather to accept Dr. Broca's first suggestion than the last, and to regard trepanning among the prehistoric men as having had a therapeutic motive.

The perforation of the tomb was almost certainly intended as a door of exit for spirits. Even in later times, when the dead were burned, holes were often bored or knocked in the urns that contained the ashes, for the same purpose. Some cinerary urns have been found with little windows, as it were, made in them, and a piece of glass placed over the hole. Macrobius, in his Saturnalia, quotes an Etruscan belief that a door should be opened for the spirits to pass in and out.

The writer remembers a case of a dying woman some few years ago in Sussex. She was gasping, and apparently was undergoing the last struggle in great distress. The nurse went to the window and opened it. At once the dying woman breathed deeply and expired. The writer said to the nurse, "Why did you open the window?" The answer given was, "Surely you wouldn't have her soul go up the chimney?"

One can understand how that, if a piece of skull had been regarded as in contact with a demon or spirit, it would be respected

as an amulet, and that so the *rondelles* removed from the heads of men who had been subject to epileptic fits would acquire a virtue in the eyes of the ignorant and superstitious, and be employed as charms. And this seems to be both the simplest and most intelligible explanation of the phenomena of hole-pierced heads, and of the wearing of the portions removed from those heads by men and women who had not themselves been trepanned.—*Cornhill Magazine.*

THE NEW STAR IN THE MILKY WAY.

A "NEW STAR" is a representative of a class of phenomena so rare that the number recorded during the last few centuries may be counted on the fingers. Hence we readily conceive that, since they are very striking in themselves as breaking the monotony of the starry heavens, and since also their nature was considered till quite recently to be shrouded in mystery, a most lively interest has been stirred up by the recent new arrival, not only among astronomers, but among that large class who are always on the *qui vive* for celestial wonders.

When tortured by the many instruments which modern science places at the observer's disposal, a new star is quite a thing *per se;* while at times their brilliancy is extraordinary, some of these "new stars" having rivaled both Mars and Jupiter in brightness, and even sometimes Venus.

The time that they take to wax and to wane varies very considerably; some have lasted at their greatest brightness only for days, others have remained visible for months or occasionally for years. It generally happens that a "new star" when first seen is brightest, and many have thought that this is simply because the star is at the stage most likely to be noticed by us; but this may not be the entire truth, as can be gathered from a consideration of the various views which have been put forward as to their nature.

Among the many hypotheses that have been suggested to explain how it is that these strange bodies make their appearance from time to time, we may first of all mention that which supposed them due to the sudden colliding of a comet with a star; another theory assumed that a star at some period of its existence became enveloped in a kind of crust or slag, which by some cause or other became disrupted, and revealed the glowing mass within.

Both these hypotheses, although they might to a certain degree explain the sudden brightness of the star, would not hold good with regard to the rapid diminution of its light, because,

if large bodies are dealt with, the cooling must take a very long time.

The latest view put forward is, that these bodies are produced by the sudden meeting in space of two swarms or streams of meteoritic matter, each traveling with a considerable velocity, the sudden bright light being due to the collisions of the particles composing the swarms; and this hypothesis explains very well not only the sudden outburst, but the rapid decrease in brightness, due to the fact that only small particles are dealt with, and these must cool and dim quickly.

The appearance of the present new star, or "Nova," in the constellation of Auriga, was first announced by an anonymous post-card received at the Royal Observatory, Edinburgh. Why the post-card was sent anonymously remains a mystery; but the extraordinary reticence of the writer does not make any difference to the immortality of the discoverer; for while, on the one hand, newly discovered comets, which are also of an apparently temporary nature, are always associated with the names of those who first observe them, new stars, on the other hand, are always referred to by the name of the constellation in which they appear.

The instrument now used to obtain observations of these strange visitors consists of a combination of an object-glass; a prism, which is placed outside the object-glass, and a camera. The function of the prism is to separate the million strands of colored light which go to make white light; that of the object-glass is to collect each color, concentrating it at the same time, so that finally we get a fine line of rainbow color.

This method of obtaining a spectrum is by no means modern, but was suggested and used by the German optician Fraunhofer about the year 1814. He placed a prism before the object-glass of a theodolite, and in this way was the first to observe the spectra of some of the stars. By the use of this method, whether the eye or the photographic plate is used, the so-called "spectrum" of the body under observation can be studied without any difficulty. The length of the exposures required when photography is employed for stars of different magnitude varies very considerably; for the brightest a few minutes are generally ample, but for those of much smaller magnitude a space of two or three hours is by no means too long.

The spectra that are thus obtained are of various kinds, as various classes of so-called stars are observed. Some consist of bright lines on a dark background, others of dark lines on a bright background while a mixture of both these is met with. These variations in spectra depend upon the fact that any substance that is heated sufficiently to emit light whether

in the heavens or on the earth, will give a spectrum. If it be a solid or liquid body, we shall have what is called a continuous spectrum—that is, a colored band bright from end to end, with no sign of any dark or bright lines about it. By continuing to heat this body until it becomes a mass of incandescent gas, the spectrum will become entirely changed, and will consist of a series of bright lines on a dark background, the number and position of the lines depending on the substance heated. But suppose, now, that the light from an incandescent solid or liquid body passes through a gas, what kind of a spectrum should we have? Experiment shows that in this case we get a continuous spectrum crossed by *dark* lines, these dark lines being produced by the peculiar power that a gas possesses of absorbing those particular rays of light which it emits. Thus we see that if we are dealing with incandescent solid or liquid bodies, we obtain continuous spectra; if with incandescent gases, bright-line spectra; and if with absorption, dark-line spectra; the position of the lines in all cases revealing the chemical nature of the substances.

So much, then, for the general idea of the nature of a spectrum. There are some additional points to be considered when we are dealing with stars. If we observe the spectrum of a star at rest, we shall obtain lines, whether bright or dark, in their normal place in the spectrum. These lines will be peculiar to certain substances, and, in fact, their presence in the star is determined simply by them. If we deal with the light from a body which is not an apparent *point*, the lines will still keep the same positions, for the same reason, but each one of them will be broadened equally.

Let us now suppose the star no longer stationary, but moving with a considerable velocity. In this case the wave-length of each line will be no longer the same; but the line will have altered its position in the spectrum to an extent depending on the movement of the star toward or from the earth. The result produced in the spectrum will be the same with regard to the number of lines as was the case when the star was assumed to be motionless, but the lines will all have received a slight shift, either to one side or the other of their initial positions, according as the star is approaching or receding. If instead of one we now deal with two stars of the same chemical and physical structure, traveling with different velocities, either toward or away from us, the spectrum would show each line doubled, and the more rapid the relative motion the coarser will be the doubling. If the stars were so physically constituted that the same chemical substances were present in both, but giving bright lines in one and dark lines in the other, the spectrum would present a series of bright lines, each accompanied by a dark one, on one side or

the other, according as the body which contained dark lines in its spectrum was approaching the earth or receding from it.

After this very brief statement of general principles, we can now refer to the observations that have already been made with regard to the spectrum of the present new star, observations unique in astronomical history, and of the highest importance and interest. It has been found to consist of both light and dark lines. The fact that pairs of bright and dark lines are seen proves that two bodies are in question. If we suppose two swarms of meteors colliding in space, the spectrum can be easily explained on this assumption in the light of the general principles referred to above. Further, the thickness of the lines tends to show that each one is produced by a large number of small incandescent masses moving at different velocities, rather than by one large one. The motion necessary to produce the doubling of these lines has been estimated, and the relative velocity of the two swarms has been put down as more than five hundred miles per second!

If the photographs should continue to show the same relative positions of the bright and dark lines, the observations would prove that this relative motion is not produced by the revolution of one body round another, but that a dense swarm of meteorites is moving toward the earth with a high velocity, and passing through another receding one of less density.

It will be seen that the observations harmonize well with the hypothesis that has been advanced on much less definite evidence; but this is not the only instance we can give of the grip that modern science has on large classes of phenomena which were supposed to be beyond the reach of man. The lines that have been photographed in the spectrum of this star are all such as could have been predicted with our knowledge of new stars.

As an instance of the advanced stage at which astro-physical science has arrived, we may say that, if we had no observations of new stars other than those already recorded of the present one, their whole theory could be obtained by induction. This may seem a "sweeping statement," but it is nevertheless true, for since many so-called "stars" are now known not to be "stars" like our sun, but simply clouds of meteoritic bodies clashing together, and since we know approximately the sequence of changes through which the spectra of these stars pass as their temperature is first increased and then reduced, each spectrum indicates the complexity of each swarm.

We have already seen that the doubling of the bright and dark lines indicates that we are dealing with two swarms in the present instance, one approaching and the other receding; we now learn that the condensation at which each of these swarms

exists can be approximately determined; that which gives us the dark lines is denser than the one which gives us the bright ones.

In conclusion, it may be well to point out a difference of some importance between comets and these new stars. A comet, as is generally conceded, consists of a cloud of meteoritic dust *traveling round the sun*, sometimes in elliptic but more often in a parabolic or hyperbolic orbit; in other words, those traveling in elliptic orbits have been captured by the sun and return to it periodically, while those pursuing a parabolic or hyperbolic orbit after one passage near the sun are forever lost to us.

Thus a comet with an elliptic orbit may be said to be a member of the solar system, and on this account can approach very near to our earth; and in fact our earth has even passed *through* one, giving rise to the phenomena of a great number of shooting-stars.

A new star, on the other hand, *never* approaches our system, but is formed at very great distances from us, distances probably as great as that of the nearest star, so that light, which travels one hundred and eighty-six thousand miles per *second*, takes about thirty years to complete its journey to us. Our new star, then, is already old.—*Saturday Review.*

THE DISCOVERY OF THE SEXUALITY OF PLANTS.

ATTENTION was called, at one of the late meetings of the Brandenburg Society of Botanists, to the fact that the two hundredth anniversary of the discovery of sexuality in plants had recently occurred. It was in fact two hundred years since the doctor and botanist Rudolf Jakob Camerarius, professor at Tübingen, separated two feminine types of the annual mercury from a group of plants of the same kind growing in a garden, and remarked that they had hollow seeds. His report on this subject, published in the Ephemerides of the Leopoldine Academy, is dated December 28, 1691. Camerarius demonstrated that plants are reproduced like animals by means of sexual organs. Till then confused notions had been entertained on the subject, and no one had thought of submitting it to an experimental test. Camerarius found that the stamens constituted the male organ and the pistils the female organs, and published the fact in his memoir *De Sexu plantarum Epistola.* The thought, like many other great discoveries that are not appreciated at the time, was too remote from current ideas to be accepted, and was comparatively overlooked,

A hundred years after the discovery of Camerarius a book appeared that cast a new and living light on the question of the sexuality of plants. Like the elder one, it also was not appreciated by the students of the time. Although Camerarius had shown, between 1691 and 1698, the necessity of the intervention of the pollen in the act of the fecundation of plants or the production of the seed—or, to use one of Goethe's expressions, that plants gave themselves up, in the bosom of the flower, to the sports of love—the special destination of the different parts of the plant remained a riddle.

But flowers, with their special properties, the richness of their living colors derived visibly from the green of the leaves, the wonderful variety of their forms, and the perfumes with which they made the air fragrant, continued to attract the attention of the learned world. In 1793 a schoolmaster, the regent Christian Conrad Sprengel, of Spandau, again withdrew the veil, and showed with rare penetration, confining himself to the genus, what were the functions of the organs of the flower, and chiefly of the colored petals. The facts he disclosed, and which are now part of the incontestable patrimony of science, appeared so surprising to him that he entitled his book The Mystery of Nature unveiled in the Structure and Fecundation of Plants. He also advised the botanists of his time to study plants *in vivo*, in Nature, instead of contenting themselves with the examination in their studies of dried and withered specimens in a herbarium. His discovery was of so great importance to the scientific explanation of the functions of the different floral organs that it is hard to explain how his book, still remarkable and interesting, could have passed unnoticed. Incredible as it may appear, it is nevertheless true that his ingenious work remained unknown till 1862, when Charles Darwin, being occupied with the same question, found it and made it known.—*Translated for The Popular Science Monthly from the Revue Scientifique.*

Mr. James Ellis Humphrey, in his book on Amherst Trees, Massachusetts, speaks of the Japanese gingko as being very interesting to botanists for representing an extreme type of development in conifers, with much specialized flower and fruit, and for being the survivor down to the present time of this type, which was very abundant and widely distributed over the earth's surface in earlier geologic ages. This plant, whose natural habitat has become restricted to China and Japan, would probably itself have disappeared, like its relatives, but for the peculiarly religious significance which has in some way become attached to it. This has led to its careful preservation in the temple groves by the Chinese and Japanese priests, and it is even stated that it is known only in cultivation, having become extinct in the wild; so that we owe our knowledge of the living tree to a superstition.

SKETCH OF ROBERT BOYLE.

THE services of Robert Boyle to science are described in the National Biography as "unique, notwithstanding occasional failing on the side of credulousness"—a failing which Sir Henry Ackland excuses as due rather to the age than to the person. Boerhaave regarded Boyle as the father of experimental philosophy, "the ornament of his age and country, who succeeded to the genius and talent of the Chancellor of Verulam," and indulged in somewhat extravagant eulogy of his work.

ROBERT BOYLE, the fourteenth child and seventh son of Richard Boyle, Earl of Cork and Orrery, was born at Lismore Castle, Munster, Ireland, January 25, 1627, and died in London, December 30, 1691. He was put into the care of a country nurse, with instructions to bring him up as she would one of her own children, his father saying that he would avoid the excessive tenderness which parents were liable to exercise toward their own children, guarding them as carefully from the sun and the rain "as if they were butter or sugar." Although the nurse carried out these instructions faithfully, her ward grew up of weak constitution and subject to many infirmities. He learned to speak Latin and French in his earliest years, but showed, as he advanced in his studies, a more decided inclination toward the sciences. When eight years old he was sent to Eton to school, leaving Ireland, according to Sir Henry W. Ackland's terse summary of his life, "in a gale of wind, and when the coast was 'infested by the Turkish Gallies'; but, after touching at 'Ilfordcombe and Minehead,' he happily arrived at Bristol. He shortly afterwards went to Eton, where (we are told) 'he lost much of that Latin that he had got; for he was so addicted to the more solid parts of knowledge that he hated the study of bare words naturally.'" The college was then under the charge of his father's friend, Sir Henry Wotton. After spending three years there, he was placed as a private pupil with the rector of Stalbridge, in Dorsetshire. In 1638 he started on his travels, under the care of a "wise and intelligent tutor," passing through Normandy to Paris, thence to Lyons, and thence to Geneva, where he stayed twenty-one months. In the autumn of 1641 he visited Switzerland and Italy, to spend the winter in Florence, where, he himself wrote, he "spent his spare hours in reading . . . the new paradoxes of that great stargazer Galileo, whose ingenious books, perhaps because they could not be so otherwise, were confuted by a decree from Rome; his Highness the Pope, it seems, presuming, and that justly, that the infallibility of his chair extended equally to determine points in philosophy and religion, and loth to have the sta-

bility of that earth questioned, in which he had established his kingdom."

"At length," says Sir Henry W. Ackland, "Boyle arrived at Rome, where he passed as a Frenchman. He was shocked by much which he saw and heard of the life and immorality of even the clergy there." He studied unceasingly, reading much on all his journeys. At Marseilles, in 1642, he learned of the breaking out of the rebellion in Ireland, a fact that was more deeply impressed upon his mind by the consequent impossibility of getting any money from home, and he did not return to England till 1644. There he learned of the death of his father, and found himself heir of certain estates in Ireland and of the manor of Stalbridge. In London, the next year, he became a member of the Philosophical College, a society of scientific men, which, in consequence of the political agitation of the times, held its meetings as secretly as possible, first in London and then in Oxford, and was called the "Invisible College." After the Restoration this society was incorporated by Charles II as the Royal Society. "The course of Boyle's life," says Sir H. W. Ackland, "must be considered as now fully determined. He had gradually acquired a keen interest both in science and theology, an interest never to be abated, and henceforth interlaced with all his thoughts and writings." In 1646 he settled at Stalbridge, and devoted himself to study, scientific research and experiments, and authorship. Visiting Ireland in 1652, he made anatomical dissections with Sir William Petty, and verified by actual experiments the circulation of the blood. He removed to Oxford, where he lived fourteen years, enjoying the society of many learned men. Here he made improvements in Otto von Guericke's air pump, and by curious experiments made various discoveries on the properties of air, the propagation of sound, etc., the most important of which was the discovery of the law called Mariotte's in the text-books, but more properly Boyle's, of the intimate relation between the volume of a gas and the pressure. He constantly, say his French biographers, opposed the teaching of Aristotle, which was still current in the schools; and was, like Bacon, convinced that the truth could be discovered only by experiment. He would not even read the works of Descartes, lest, finding in them more imagination than observation, and hypotheses rather than facts, he should be tempted out of his chosen path. None of the scientific systems then in vogue were received by him. In particular he brought experimental demonstrations to bear against the theory that salt, sulphur, and mercury were the essential principles of bodies. He allowed matter no properties but mechanical ones. To him we owe the exact determination of the fact that air is absorbed in calcinations and combustions, and that metallic calces

are heavier than the original metals—observations which long afterward served as one of the bases for modern chemistry. By completing the air pump, Sir Henry W. Ackland says, he "revolutionized the instrumentalities by which the atmosphere of the earth, the gases, many phenomena of life, and infinite chemical actions may be forever studied. It led, I doubt not, to the suggestion of rules proposed for the investigation of the Peak of Teneriffe—no small effort in the seventeenth century—and thus attempted to settle one physical problem which was set forth with great detail and precision by the Royal Society of the time." In his essays on this instrument, he "foresaw the far-reaching results through its agency of a more precise knowledge of the physical and the chemical properties of the atmosphere, . . . its relation to all organic life, and to meteorology in the widest cosmical sense. Henceforward he applied himself to experiments with this instrument, combined with his increasing power of chemical investigation, into almost all matter, above, upon, and within the globe; to vapors, to metals and stones of every kind. He studied respiration in the higher animals, investigated the effects of respired air on birds, on reptiles, on snails, and on plants, and the manner of death in each. Though experiments on living animals such as could then be performed were abhorrent to his tender soul, yet the knowledge of Nature was to him a religion; and he had to pierce through the secrets of life, the cause of disease, of suffering, and of death by every means that his ingenuity could devise."

When the Royal Society was incorporated, in 1663, Boyle was named a member of the Council. He was elected president of the society in 1689, but declined to serve in the office on account of his scruples against taking the oath. He was at one time interested in alchemy, and carried on experiments on the transmutation of metals. In the interest of this business he secured the repeal of the statute against multiplying gold and silver.

The religious side of Boyle's character was as prominent as the scientific side. Some experiences that happened to him in early youth gave a tinge of melancholy to his disposition; and he was moved by the reflections to which he was led by this trait to give himself for a considerable time wholly to an inquiry into the principles and the evidences of Christianity. Vital and sincere as was his faith, he was occasionally troubled with doubts, which he spoke of as being to the soul like toothache to the body, not mortal, but very inconvenient. The works of apologetics current in his time did not satisfy his mind, and he went to the original sources, studying Hebrew and the Oriental languages, and calling in the aid of the best theological scholars contemporary with him. The result of this inquiry was a conviction, the intensity of which was manifested by a great activity in religious discussion and reli-

gious work. He founded a lectureship on the evidences of Christianity; contributed liberally to projects for the spread of the gospel in India and America; bore the expense of publishing translations of the Gospels and the Acts of the Apostles into Malay, and of publishing an Irish Bible; contributed to the publication of the Welsh Bible and a Turkish New Testament; and aided with money in Pococke's translation of Grotius's De Veritate into Arabic. The learned Sanderson having been deposed from his benefice on account of his loyalty to Charles II, he gave him a pension on condition that he would write a work on questions of conscience. When invited to take orders in the Church, he declined to do so, on the ground that that was not his vocation, and that his writings on religious subjects would have greater weight coming from a layman than from a paid minister.

Boyle left Oxford about 1668 and settled in London, fixing his residence in the house of his sister, Lady Ranelagh. His health began to fail seriously about 1690, and he was obliged to withdraw gradually from all his public engagements. He discontinued his contributions to the Royal Society, resigned his office as governor of the corporation for the propagation of the gospel in New England, and announced publicly that he could no longer receive visits. He devoted his time to chemical investigation, the accounts of which he left "as a kind of hermetic legacy to the studious disciples of that art." His health continued to grow worse, and his death occurred precisely one week after that of his sister, with whom he had lived for twenty years. By his will he founded and endowed the Boyle Lectures for the demonstration of the truth of the Christian religion "against atheists, theists, pagans, Jews, and Mohammedans."

Boyle was never married. In person he was tall, slender, and of a pale countenance. "While his scientific discoveries procured him wide and lasting renown, his private character and virtues, the charm of his social manners, and his wit and conversation endeared him to a large number of personal friends."

Boyle's place in science should be estimated by the relation of his work to his time, not to ours. He was a leader, much in advance. Sir John Herschel says that he "seemed animated by an enthusiasm of ardor, which hurried him from subject to subject, and from experiment to experiment, without a moment's intermission, and with a sort of undistinguishing appetite." Sir Henry W. Ackland suggests that he had so many qualities, and pursued so many lines of thought, that they almost dim one another. From his "quality of prudence, and from his steadfast adherence to the supreme test of experiment, he was led to doubt and to test several opinions in the science of the day, and to overthrow dogmas which had been unquestioned. This skepticism in scientific mat-

ters influenced his mind at every moment, and is apparent in many of his treatises on several 'cosmical' subjects which deeply interested him; but his scientific convictions, formed on adequate grounds, and on any subject-matter, were immovable. It is probable that the greatest service he did to his country and to mankind was by kindling in the minds of his contemporaries an enthusiasm for science, a desire to explore and know Nature, in those turbulent and disastrous days when Wilkins's and Wallis's papers were burned by the mob, Harvey's anatomical dissections destroyed, and Gresham College turned into barracks. In his day he, more than almost any other man, kept alive the torch which kindled the undying fire of the Royal Society."

Bishop Burnet, a contemporary and a man of the court, says: "His knowledge was of so vast an extent that, if it were not for the variety of vouchers, in their several sorts, I should be afraid to say all I know." After referring to his knowledge on theological matters, the bishop continues: "He ran the whole compass of the mathematical sciences, and, though he did not set himself to spring new game, yet he knew even the abstrusest parts of geometry; geography, in the several parts of it that related to navigation or travelling; history and books of travel were his diversions. He went, very nearly, through all the parts of physic; only the tenderness of his nature made him less able to endure the exactness of anatomical dissections, especially of living animals, though he knew those to be the most instructing; but, for the history of Nature, ancient and modern, of the productions of all countries, of the virtues and improvements of plants, of ores and minerals, and all the varieties in them, he was by much, by very much, the readiest and the perfectest I ever knew, in the greatest compass, and with the truest exactness. This put him in the way of making all that vast variety of experiments, beyond any man, as far as we know, that ever lived. And in these, as he made a great progress in new discoveries, so he used so nice a strictness, and delivered them with so scrupulous a truth, that all who have examined them have found how safely the world may depend upon them. But his peculiar and favorite study was chemistry, in which he engaged with none of those ravenous and ambitious designs that draw many into them. His design was only to find out Nature; to see into what principles things might be resolved, and of what they were compounded, and to prepare good medicaments for the bodies of men."

Of Boyle's scientific works, the earliest was New Experiments, Physico-mechanical, touching the Spring of Air and its Effects, published in 1660. It was followed, in 1662, by The Sceptical Chemist, which was afterward reprinted, with additions. In 1663 he published the first part, and in 1671 the second part, of Consid-

erations touching the Usefulness of Experimental Philosophy. He also published, in 1663, an important volume of Experiments and Considerations upon Colors, with Observations on a Diamond that Shines in the Dark. Other scientific works are, New Experiments and Observations upon Cold, 1665; Origin of Forms and Qualities according to the Corpuscular Philosophy, 1666; Tracts about the Cosmical Qualities of Things, the Temperature of the Subterraneous Regions, and the Bottom of the Sea, 1669; Origin and Virtues of Gems, 1672; Essays on the Subtilty and Determinate Nature of Effluvia, 1673; tracts on the Saltness of the Sea, the Moisture of the Air, the Natural and Preternatural State of Bodies, Cold, Hidden Qualities of the Air, Celestial Magnates, Hobbes's Problem of a Vacuum, and the Cause of Attraction and Suction, 1674; Experiments and Notes about the Mechanical Origin or Production of Particular Qualities, including a Discourse on Electricity, 1676; the Aërial Noctiluca, or some New Phenomena, and a Process of a Factitious Self-shining Substance, 1680; New Experiments and Notes upon the Icy Noctiluca, to which is added a Chemical Paradox; Memoirs for the History of Human Blood, 1684; Short Memoirs for the Experimental History of Mineral Waters, 1685; Medicina Hydrostatica, 1690; Experimenta et Observationes Physicæ, 1691; and, published after his death, the General History of the Air Designed and Begun; an account of his making the phosphorus, September 30, 1680; and Medicinal Experiments. Most of the volumes of his works, with many manuscripts, exist in the library of the Royal Society. The works were collected in five folio volumes in 1744; a more complete edition, in six large quarto volumes, with a life by the editor, Dr. Birch, published in 1772, contains most of his scientific writings, several theological treatises, and numerous letters from him and to him.

THE purpose of a book by Paolo Riccardi on Anthropology and Pedagogy is to show what aid anthropology can bring to the science of education. The school, according to his view, should not be regarded as an assemblage of children of every class, connected with one another only by the four walls of a common inclosure; but as a social organism, a little society in which the child is to be taught to live, and prepared for the future life in the larger society of adults. He asks anthropology to make this preparation. The teacher's first effort should be to determine the relative strength of his pupils, and the possible relations between superior and inferior vigor and intelligence, between the moral and the organic condition of each.

THE officers of the Russian vessel Aleut have identified the burial place of Bering, the discoverer of the straits that bear his name, on Bering Island, and have erected upon it a granite monument tipped with an iron cross.

EDITOR'S TABLE.

PRESIDENT ELIOT ON PUBLIC-SCHOOL EDUCATION.

THE article contributed by President Eliot to the December Forum, under the title Wherein Popular Education has Failed, is one of the weightiest utterances on that subject that have fallen under our notice in recent years. It is weighty in its moderation, in the clearness and force of the indictment it formulates, and in the precision with which it indicates the remedial measures to be taken. Need we add that it is weighty also through the recognized eminence of its author in the field of education? It would be hard to mention any voice in this country that speaks with more authority upon any educational question than that of President Eliot.

The opening statement of the article is terse and pointed: "It can not be denied that there is serious and general disappointment at the results of popular education up to this date." During two whole generations State-supported schools have been in full operation. These have been devised and maintained on such a scale as to bring the whole, or nearly the whole, population under their influence; and yet, with elementary education almost universal, we do not seem to have a wiser, a more virtuous, or a happier people. President Eliot admits that some important improvements have taken place during the last two generations: penal codes have been reformed; prisons are better ordered; hospitals, asylums, and reformatories have been provided on a much larger scale than formerly; the general condition of the working classes has improved; the average duration of human life has been increased; and education, he is disposed to believe, has had some share in bringing about these ameliorations. In saying this the writer of the article goes perhaps as far as can be done with safety. Prison reform and the abolition of the slave trade were burning questions before any great movement for popular education had set in, and the same might be said of other humanitarian and socially useful movements. At the same time there is no doubt, as President Eliot suggests, that, where the population in general can read, there is formed a public opinion which renders the retention of abuses more difficult.

Still, notwithstanding all that education and other agencies of an enlightening character have done, the condition of things as regards popular intelligence is far from satisfactory. To quote from the article before us: "In spite of every effort to enlighten the whole body of the people, all sorts of quacks and impostors thrive, and one popular delusion succeeds another, the best-educated classes contributing their full proportion of the deluded. Thus, the astrologer in the middle ages was a rare personage and usually a dependent of princes; but now he advertises in the public papers and flourishes as never before. Men and women of all classes, no matter what their education, seek advice on grave matters from clairvoyants, seers, Christian scientists, mind-cure practitioners, bone-setters, Indian doctors, and fortune-tellers. The ship of state barely escapes from one cyclone of popular folly, like the fiat-money delusion or the granger legislation of the seventies, when another blast of ill-informed opinion comes down on it, like the actual legislation which compels the buying and storing of silver by Government, or the projected legislation which would compel Government to buy cotton, wheat, or corn, and issue paper money against the stock."

The great trouble is, says President Eliot, that our popular education is not really conducted in such a way as to develop intelligence. It teaches children to read (after a fashion), to spell, to write, and to cipher; it also imparts a little knowledge of geography; but none of these things, as commonly taught, calls into activity in any adequate manner those powers on the due exercise of which the growth of intelligence depends—the power of observing facts, the power of accurately and faithfully recording facts, the power of reasoning correctly in regard to facts. Nor is any sufficient practice given in the important art of composition or correct expression in writing. To give a proper training in the observation of facts some branch of natural science or some kind of handicraft should be taught. At present whatever quickness of observation children acquire is acquired in connection with their sports; and their school studies lack vitality and effect simply because the element of original observation has no part in them. To make an observation of one's own in regard to any matter is to gain at once an interest in that matter, and in all probability to prepare the way for other observations. While we agree with President Eliot that some branch of natural science or some "well-conducted work with tools or machines" furnishes the best means of developing the observing faculty, we also agree with him in holding that almost any line of study may, in the hands of a competent teacher, be turned to good account for the same purpose. As he rightly observes, one teacher will get better results out of one subject and another out of another. Geography, which, "as commonly taught, means committing to memory a mass of curiously uninteresting and unimportant facts," may, under proper treatment, become a most stimulating study; but, in order that this may be the case, a teacher is required who has a vivid apprehension of the relation of geographical facts to one another, and a clear conception of the general relation of physical to political geography. So with language: it may be made a mere thing of arbitrary rules or it may be exhibited in its vital connection with thought, and its structure and etymology made to yield abundant exercise both for the observing and the analytical faculties.

In the recording of facts opportunity is given both for the cultivation of accuracy of statement and for the acquisition of correct modes of expression. We do not, indeed, see how first lessons in composition could be given with greater advantage than in connection with the statement of facts observed by the pupil. Every fact is observed under some conditions of place, time, etc., and, in the due setting forth of these, various adverbial and other elements of a well-developed sentence come into requisition. There is no point at which the inefficiency of our higher schools has been more apparent, or has given rise to severer criticism, than in the matter of composition; and the reproach will remain until the problem of its removal is approached in a scientific spirit and by scientific methods. Language is the garb of thought, not a substitute for thought, nor a thing to be acquired and possessed independently of thought. He alone can use language with freedom, certainty, and accuracy who is conscious of *needing* for the expression of his thought all the words and phrases that he employs. First catch your thought and then array it suitably. A lesson in language should therefore always be a lesson in thinking; and words, instead of appearing, as they so often do in language lessons, as meaningless superfluities, should be exhibited as essential for that communication of our thoughts on which the whole of our rational and social life depends. Language lessons in the earlier stages should always turn upon such words, phrases, and narratives as actually relate to the daily life of the child. Thought

should be stimulated until the *need* for language to express it is felt, and language should never be presented for use or imitation beyond the limits of such consciousness of need. The more the different lessons which the child receives can be brought into relation with each other, the better it will be: arithmetic and grammar, for example, may be made to support each other in the following manner. A child reports: "A big dog barked at me as I was coming to school this morning." Now this sentence may be continued in either of two ways: "And frightened me a good deal," or, "But did not frighten me a bit." In the first case we have what, by analogy, may be called *addition*, and in the second what, by analogy, may be called *subtraction:* on the one hand, the fright superadded to the barking heightens the significance or seriousness of the occurrence; on the other, the indifference of the child to the barking makes little of the occurrence. The first phrase, which has the effect of addition, is introduced by "and"; the second, which has the effect of subtraction, is introduced by "but," and a key is thus afforded to the proper use and practical effect of these two prepositions.

President Eliot makes a very true remark when he says that correct reasoning can best be taught by the study of the best classical examples of sound, forcible, and well-sustained argument. "The actual arguments," he says, "used by the participants in great debates should be studied, and not the arguments attributed to or invented for the actors long after the event. . . . As examples of instructive arguments I may cite Burke's argument on conciliation with the American colonies, and Webster's on the nature and value of the Federal Union; the debate between Lincoln and Douglas on the extension of slavery into the Territories; the demonstration by Sir Charles Lyell that the ancient and the present systems of terrestrial change are identical; the proofs contrived and set forth by Sir John Lubbock that the ant exhibits memory, affection, morality, and co-operative power; the prophetic argument of Mill that industries conducted on a great scale will ultimately make liberty of competition illusory; and that well-reasoned prophecy of disturbance and disaster in the trade of the United States written by Cairnes in September, 1873, and so dramatically fulfilled in the commercial crisis of that month." Of course, for younger pupils simpler examples of reasoning would have to be found, or possibly their own daily experience might suggest a sufficient number of questions upon which to employ and exercise their reasoning faculties.

Here, however, we are compelled to pause, and suggest a difficulty. President Eliot tells us what ought to be done, but he does not satisfy us as to what persons are going to do it. Why have not all these things been done before? Why are they not being done in all our schools now? Is it because no one has perceived or made clear to others how intellectual life may best be awakened and strengthened? By no means. The world is well supplied to-day with sound and valuable works on every branch of the science of education. The trouble is, that to awaken thought we require *thinkers;* and the public-school teachers as a body are not thinkers. As a body they are, in this respect, nowise superior to any other class of ordinarily educated persons. How, then, can we expect any early or general improvement in the present routine methods, the general results of which, so far as the production of intelligence is concerned, are acknowledged to be so unsatisfactory? The State has taken up the business of education and made it almost a monopoly, and the State-appointed teachers are such as the State can get. But how many persons with a decided vocation for education take service in the public schools? Not many, we imagine, for the simple reason that the consciousness of

such a vocation and the thought of working by prescribed routine methods are very apt to clash. Yet what is the man or the woman with such a vocation to do? Set up in opposition to the State? Well, sometimes they do, and in certain parts of the country private schools are gaining steadily on the State-supported ones, but manifestly the competition of the State is a serious thing to reckon with, and quite sufficient to deter many a one from following his or her strong desire and bent. We are disposed to believe that in this way the larger part of the special talent which would otherwise go into the work of education is diverted into other channels. All we can do, therefore, for the present is to unfold and enforce right methods, as President Eliot has done in his article, hoping that here and there the good seed may fall on good soil and yield fruit abundantly.

LITERARY NOTICES.

LES ALTÉRATIONS DE LA PERSONALITÉ (Disorders of the Personality (or Consciousness)). By ALFRED BINET. Paris: Félix Alcan. Pp. 325. Price, six francs.

PHYSIOLOGISTS and philosophers have been much interested during the last fifteen years in researches in pathological psychology, based upon the study of hysteria and suggestion; and a considerable quantity of observations and experiments has been collected in a very short time. Hallucinations, paralyses by suggestion, morbid affections of the personality or consciousness, disorders of the memory and of the muscular sense, suggestions in the waking state and during hypnosis, and unconscious suggestions, are some of the principal questions that have been examined and profoundly searched into. Numerous discussions have arisen among the investigators as the researches have multiplied and extended; discordant theories have been put forth, and important assertions made by some have been disputed by others, and school has been arrayed against school. Such controversies, which appear inseparable from new systems and are useful in their way, have cast some doubt on the real value of the collected material. The author's intention in writing this book is not to continue controversies or to oppose his own experiments to those of other observers, but, collecting all the results that have been reached, to inquire what ones among them are in accord and can be grouped under a common synthesis. For this he retains only the experiments which, repeated by many or all of the observers, have led to the same conclusion, whatever might have been the object of the experimenter, while he has put aside without judging concerning them, phenomena which have been observed by only a single person, and which do not logically relate themselves to an assemblage of known and acquired facts—subjecting his own observations, too, to the operation of this rule. The phenomena of double personality or consciousness include those in which the two states succeed or alternate with one another—successive personalities—and those in which they are coexistent. The modifications or transformations in the former case are spontaneous or provoked. It is mentioned as an advantage in the study of the spontaneous phenomena, and as a reason for beginning the discussion with them, that they are influenced only in the most insignificant degree, if at all, by the persons who observe them. They have not been prepared at long range and unconsciously by an author whose opinion was already formed; they consequently respond to no preconceived theory. They consist of incidents of hysteria, dreaming, intoxication by various drugs, aberrations caused by disordered circulation, and effects of epilepsy. In these cases the patient has, psychologically, two lives, quite distinct from one another—his usual normal life, and his life under the influence of his aberration—in either of which he has no consciousness or recollection of his experiences in the other; while, on the other hand, he often takes up the thread of life in either stage, when he resumes it, where it was dropped on coming out from the last preceding spell. Somnambulism affords the most familiar instances of this form of double personality. The study of provoked somnambulism, or hypnotism, is more subject to error, and the distinction between the hypnotic and the normal state is not so clearly marked as in spontaneous somnambulism. But experimentation has the

great advantages over the observation of spontaneous manifestations that, under it, the conditions of the observation can be indefinitely multiplied and varied, the phenomena can be regarded under a large number of phases, and it can sometimes arouse new phenomena which passive observation could never have reached. Coexistent personalities, or the simultaneous existence of two selfs, among which the still obscure and doubtful phenomena of spiritualism are included, are of two classes: first, hysteric insensibility, where a part of the body is insensible to what is going on, while the nervous centers in relation with the same region may continue to act, as in hysteria, from which it results that certain acts, sometimes simple, but often very complicated, may be accomplished unconsciously in the body of the hysteric, which acts may, further, be psychical, and exhibit an intelligence consequently distinct from that of the patient, constituting a second self; and, second, a particular attitude of the mind, concentration of attention upon a single point, by virtue of which the mind becomes distracted and as it were insensible, opening the way to automatic actions; and these actions, in their complications, like those in the other case, may take on a psychical character and constitute parasitical intelligences, living, unknown to it, by the side of the normal personality.

A third part of the essay is devoted to the discussion of the disorders in the personality provoked in experiments in what is called hypnotic suggestion, as when a person in a condition of artificially provoked somnambulism is made to execute what is suggested to him by the operator. The attempt is made to show that the suggestion usually provokes a division of consciousness and can not be realized without it. Suggestions are divided into two groups—those directly intended to produce a new personality, and those which, while having some other purpose, can not accomplish it except by causing a division of consciousness. In this part are considered hallucinations, the measurement of time by suggestion, systematic anæsthesia, the doubling of personality, and spiritualism.

The conclusions drawn from the whole are, that the self is composite, a grouping or resultant of several elements. The unity of our normal and mature personality exists, indeed, and no one should think of doubting its reality; but there are pathological facts to prove that that unity must be sought for in the co-ordination of the elements that compose it.

TAXATION AND WORK. By EDWARD ATKINSON. New York: G. P. Putnam's Sons, 1892. Pp. 296. Price, $1.25.

THIS volume forms Mr. Atkinson's contribution to the recent tariff discussion, the outcome of which has been so disastrous to the advocates of high protection. Though the successive chapters appeared first as articles in the daily papers, the book lacks nothing on that account, in the way of thoroughness or the logical grouping of the subjects considered. The discussion takes a wide range, covering not only the relation of a protective tariff to industry, wages, and the revenue needs of the Government, but the relation of a depreciated currency to the same as well. Mr. Atkinson opens his discussion with a consideration of taxation in terms of work, and presents very forcibly and graphically the truth, so frequently lost sight of, that a government can have only what it takes from the people. When it is realized that this demand upon the people is at present equivalent to the labor of a million men at two dollars per day, and that the total number of people engaged in gainful occupations is but twenty-three millions, the great importance of the subject of taxation becomes manifest. In discussing the cost of a protective tariff, Mr. Atkinson shows with especial clearness how extravagant this method of taxation may be. The cost to the country, so far from being measured by the amount of the tax, may be, and generally is, many times greater. This is particularly true of taxes upon raw materials, which, by raising the cost of manufactured articles, curtail our markets and subject us to an indefinite and undeterminable loss. Mr. Atkinson estimates that the cost to the country during the past year of such taxes, which have yielded only fourteen millions of revenue, has been not far from three hundred millions of dollars.

The strength of the protective system in this, as in every other country, lies in its supposed effect in raising wages. The fallacy of this has been many times demon

strated, and Mr. Atkinson adds his word to that of others who have written upon the subject.

He thinks that the effect of the tariff on wages has been greatly overestimated by both free-traders and protectionists. The number of those who can be directly benefited in their wages by a tariff is for the country as a whole not much over five per cent. Wages have steadily risen in the last twenty-five years, and the rise has been much more rapid in the non-protected than in the protected industries. The tariff cuts but a small figure as a factor in determining wages, and so far as it is an element its tendency is to lower wages. Mr. Atkinson considers that the important factor in raising wages is the steady improvement in the tools and processes of the mechanic arts, agreeing entirely with Mr. Schoenhoff that a high rate of wages is the necessary concomitant of high efficiency and low cost of production. His discussion of bimetallism, though brief, is clear and to the point. He arranges it in the form of a number of propositions, as the readiest means of exposing the essential elements of the question to the understanding of the reader. It is perhaps unnecessary to state that he shows clearly the folly of the silver advocates. Taken as a whole, this discussion is one of the strongest and clearest presentations of the tariff question in all its bearings which the current interest in the subject has brought forth, and it can be unreservedly commended to those seeking light upon this important issue.

EXPERIMENTAL EVOLUTION. By HENRY DE VARIGNY. London and New York: Macmillan & Co., 1892. Pp. 271. Price, $1.50.

PROF. DE VARIGNY has gathered together in this volume five lectures delivered by him before the Summer School of Art and Science at Edinburgh, advocating the desirability of experiments in organic evolution to prove in a direct way the birth of new species of plants and animals out of antecedent ones. In his discussion of the character of the proofs we now have of evolution, he points out that they are all inferential, and, while they are convincing to the great body of naturalists who have studied the facts, he thinks that the main contentions of the evolutionist can be demonstrated beyond question by direct experiment. Already much experimenting of this kind has been done, which has resulted in the production of a great number of varieties, but this has not been carried on systematically through a sufficient period nor simply with reference to the scientific value of the experiments. The lectures are very suggestive in an important line of scientific work, and will doubtless receive adequate attention from the naturalists.

THE FARMERS' TARIFF MANUAL. By DANIEL STRANGE. New York: G. P. Putnam's Sons. 1892. Pp. 363. Price, $1.25.

MR. STRANGE has given in this volume a very excellent tariff talk to the farmers. He is himself a farmer, and is therefore able to bring to the attention of the farmers in an effective way the things in our tariff medley which bear most directly upon their interests. The author's method of dealing with the subject is to take a quotation from a speech or the writings of well-known protectionists and comment upon it. As such quotations embody the points made by protectionist orators in the current discussions of the tariff issue, this method has considerable advantage over the systematic treatment of the subject by economists. The work is divided into four main parts, devoted to a Tariff for Revenue, Theories of Protection, History of Protection, and the Practical Results of Protection. The author deals with the first of these divisions very briefly. He does not believe in such a tariff on account of its extreme inefficiency, but holds that all taxation should be direct. In the division devoted to theories of protection he disposes in very short order of the ridiculous claim of the latter-day protectionists that the foreigner pays the tariff tax. He also considers Mr. Blaine's wonderful reciprocity scheme, and once more endeavors to make clear to the average man the meaning of a "balance of trade." In the historical division he gives a brief account of the successive tariffs from the foundation of the Government down, which the protectionist farmer, who is at all open to conviction, will find very instructive reading. The book closes with a review of the practical results of protection, and an earnest appeal to the farmers of the country to drop all side issues,

such as have been advocated by the various farmer organizations, and concentrate their attention upon the one overmastering issue of the tariff. It has long been recognized that the ultimate disposition of the tariff question lies with the farmers. They constitute forty per cent of those engaged in gainful occupations, and in the very nature of their occupation can not be benefited by the tariff while the cost of nearly everything they buy is enhanced by it. Whenever they thoroughly realize that the tariff is a tax and is paid by the consumer, that the current appeals of protectionists are the merest sophistries, they have it in their power to make very short work of this antiquated system. There are not wanting signs that a good many farmers are coming to a sense of the real state of the case, and books like that of Mr. Strange can not but help them to reach rational conclusions.

LIGHTNING CONDUCTORS AND LIGHTNING GUARDS. By OLIVER J. LODGE. London: Whitaker & Co. New York: Macmillan & Co. 1892. Pp. 544. Price, $4.

THIS volume is a discussion of the subject of lightning protection, in view of the recent advances which have been made in our knowledge of currents of high potential and high frequency. It contains two lectures before the Society of Arts, as well as a number of miscellaneous papers upon the general subject. Prof. Lodge takes exception to the current view that conductivity is the main thing to be considered in an efficient lightning protector. Experiment has shown that, even with lightning rods of many times the conductivity necessary to carry off a current of the dimensions of a lightning stroke, the lightning refuses to follow the conductor, and makes all sorts of curious detours through paths of enormously high resistance. This phenomenon, which is inexplicable on the theory that a lightning flash is simply a high-tension current for which a conducting path must be provided to assure its safe disposition, finds ready explanation on Prof. Lodge's theory. He likens the lightning discharge to a blow on the water contained in a pipe. If the blow be quick enough, the water will not be set in motion, but the pipe will burst. The remedy is, not to make the pipe larger, but to make it elastic. A lightning flash, in this view, is a disruptive discharge between the opposite surfaces of a condenser through the intervening dielectic. The clouds form one surface of this condenser and the earth the other, the intervening air being the dielectic. It is now well known that the discharge of a condenser is alternating and of great frequency. The discharge of a condenser of such a great extent of surface as that presented by the clouds and the earth, Prof. Lodge maintains, must be not only of enormous tension and frequency, but of large current volume as well. It is commonly stated that the amount of current in a lightning discharge is very small indeed, and this is quite true. The discharge, however, occupies but an infinitesimal fraction of time. If it were prolonged so as to make it comparable with our standards of current, the current flowing would be at the rate of thousands of ampères per second. In this view of lightning discharge, lightning protection is not so simple a thing as has generally been supposed. Instead of providing simply a drain for the electric fluid, lightning protection has to devise means for escaping a tremendous blow, delivered with almost inconceivable rapidity. Happily, we are not helpless in the presence of this requirement. It has long been known that no charge resides in the interior of a closed metal chamber, no matter how strongly the surface is charged. Such a chamber is, of course, impracticable as a means of protection, but a metallic network will answer nearly as well and is practicable. Prof. Lodge's practical suggestions, therefore, take the form of multiple wires, all connected together to form a large mesh network, and terminating at the roof in points. These points may be roughly fashioned, as there is no practical difference in protection between rough and highly finished points. There is no advantage in carrying the points high up in the air, as this simply invites a discharge which might not occur. Such a network, well grounded, he conceives, will form ample protection in most cases. The wires used need not be larger than ordinary telegraph wires, and, as resistance is a matter of no moment, iron will do as well as copper. The great importance of adequate lightning protection renders such a discussion of the subject as Prof. Lodge has here given us of no little

value from the practical point of view, while the scientific aspect of the subject can not fail to interest and stimulate the intelligent reader.

PHYSICS, ADVANCED COURSE. By GEORGE F. BARKER. New York: Henry Holt & Co., 1892. Pp. 902. Teacher's price, $3.50.

ONE of the most obvious and radical changes wrought by modern investigation in the science of physics is the greater importance which the phenomena of energy have assumed. Until comparatively recent times matter was considered the far more essential factor, and received a considerably larger share of attention. The reverse is now the case, and, as Prof. Barker well says, "The physics of to-day is distinctively the science of energy. Henceforth every physical change must be regarded as conditioned upon the transference or the transformation of energy. Hence, the classification which has been adopted in the present work is based on the most recent views of energy, considered as being ultimately a phenomenon of the ether."

The introductory portion of this book deals with the general physical relations and the laws of motion. Energy is next treated of as a mass condition, and work as the transference or transformation of energy. Potential is considered as a consequence of mass attraction. Matter is then treated of with reference to the modern views of its structure. Heat comes next, under the head of molecular physics. The remainder of the work is devoted to the phenomena of the ether, which are classified as follows: ether vibration or radiation; ether stress or electrostatics; ether vortices or magnetism; and ether flow or electrokinetics. The metric system is used throughout. What illustrations there are are well placed, but they are not as numerous as might be wished. There is a detailed table of contents, and a useful index.

The book is not, like many scientific works, an encyclopædia, nor is it, as some of the others are, a purely theoretical treatise. It combines very happily the important experimental facts of the science with the more probable theory or theories based upon their consideration. It fully justifies Prof. Barker's reputation as a thorough scientist. It is written in a plain and lucid style, and is very readable. The author's treatment of the subject varies somewhat from that of the old standards, but it is a treatment which recent work has been increasingly leading up to, and, in fact, making necessary.

The old text-books, notwithstanding frequent revisions, are unsatisfactory, and a new book, not only embodying the results of the most recent investigations, but also applying these results in the treatment of the subject as a whole, has been a growing necessity. Prof. Barker has given us just such a book, and it is fortunate that so careful and thoroughly equipped an author was at hand.

MANNERS AND MONUMENTS OF PREHISTORIC PEOPLES. By the MARQUIS DE NADAILLAC. Translated by N. D'ANVERS. New York: G. P. Putnam's Sons. Pp. 412. Price, $3.

ANY one who wishes to have a handsome volume, fully illustrated, and giving a remarkably interesting account of the discoveries that have been made in regard to the peoples that lived before any mode of writing was invented, should get this work of De Nadaillac. The author begins with a general sketch of the stone age, in which he shows that its duration and its place in time can not be set off by any hard-and-fast bounds. He then proceeds to tell what has been learned as to the food of early man, which involves the subjects of prehistoric hunting, fishing, and cannibalism. The author names the horse, the aurochs, the stag, the reindeer, and other animals as furnishing food for the ancient men of Europe, and he names place after place where human bones, charred, and all those containing marrow broken, just as the bones of the lower animals were treated, give evidence of cannibalism. In rapid succession he touches upon the numerousness of animals in the stone age, the weapons used by man in killing them, the implements used in fishing, and various early efforts at navigation. Taking up weapons, pottery, and other articles of use or ornament more in detail, he describes implements from the caves of France, the river valleys of America, and from England, Italy, Spain, Algeria, and Hindostan. He speaks of pottery from Germany, Italy, France, Belgium, and other countries. This leads to a few words on the ancient use of fire, after which come descriptions of orna-

ments in various materials, and of the carvings on horn, bone, and wood, which testify to the artistic ability of the man of the stone age. The next chapter is devoted mostly to dwellings, and in it we find described the earth holes of France and South America, the natural caves used as abodes, especially in France, the lake stations of Switzerland, the crannoges of Ireland, the burgs of Scotland, the nurhags of Sardinia, the talayoti of the Balearic Isles, and the castellieri of Istria. Megalithic monuments are treated with no less fullness than are the dwellings, and the same may be said in regard to fortifications. There is also a brief summary of Dr. Schliemann's discoveries on the site of Troy. A somewhat miscellaneous chapter deals with industry, commerce, social organizations, fights, wounds, and trepanation; and the volume ends quite appropriately with tombs. One hundred and thirteen figures illustrate the text.

LONGMANS' OBJECT-LESSONS. By DAVID SALMON. Revised and adapted to American Schools by JOHN F. WOODHULL. New York: Longmans, Green & Co. Pp. 238. Price, $1.

THESE lessons are intended for children in infant or primary schools, and full notes are given for a course which may extend through four or five years. Plants, animals, and the common properties of substances are studied at first; later on, the general principles of chemistry, physics, and botany are considered. The first part of the work is devoted to hints for teachers, and a strong plea is made for early training. Many children enter upon life ill equipped, since their school education ends before the definite study of science begins.

The method of the author is excellent, but a false idea is conveyed by illustrating modes of manufacture which have been superseded, as that in the making of pins.

The book is fully illustrated, and provides blank notes for teachers and an index.

THE STORY OF KASPAR HAUSER. By ELIZABETH E. EVANS. London: Swan, Sonnenschein & Co. Pp. 188. Price, $1.75.

THE pathetic tale in this volume will appear entirely credible to those who read it here for the first time. Even in these days of quick intelligence and watchful societies children are abducted, secreted, and finally lost to their friends, so that at the outset it is not improbable that such a scheme should have been effectual in past times with the heir to a royal house. The preponderance of proof is that Kaspar Hauser was indeed the Prince of Baden. Supposing that a group of such diverse characteristics as the city officials, a scholarly professor, and noted criminal lawyer could be easily deceived, the autopsy performed in another city showed their observations to be well founded. The abnormal flatness of knee-line, the enlarged liver, and undeveloped brain were unimpeachable witnesses. The portrait given ought also to furnish some evidence if it bears a marked family resemblance. The literature that has grown up on this subject is quite extensive. A list of forty-five books and pamphlets is appended for those who wish to consult the original testimony.

NATURE STUDY. By WILBUR S. JACKMAN. Second edition, revised. New York: Henry Holt & Co. Pp. 448.

THE teacher of elementary science in the common school has not only his class to instruct in the study of Nature, but probably himself; and this volume is designed to guide him in this task of manifold difficulty. An acquaintance with scientific fact and principle can be gleaned from books, but the method, which is generally an untrodden way for him, must be learned by individual effort, and it is advised that he should begin and work with his pupils. The plan of the book is altogether novel. An outline of subject matter for a year's course of lessons is given; this is divided into twelve sections corresponding to the months. In each of these an effort is made to study the special phenomena of the season, chiefly by practical work. Although no illustrations are furnished, explicit directions are given for performing experiments, collecting specimens, and keeping mineralogical and meteorological records, charts for which are also published separately. Topics are indicated by questions, but it is not intended that the teacher shall use these except as suggestions. Class work can be varied by drawing, painting, modeling, and the making of apparatus.

The list of sciences entered upon is long. A weekly lesson is prescribed in zoölogy and

botany; physics, meteorology, astronomy, geography, and geology receive attention once in two weeks; chemistry and mineralogy once a month. The author, however, considers the exaltation of one science above another and the artificial sequence found in various curricula very misleading. The life of the individual is the natural center of interest, and each science has its value in revealing the forces that modify it. This idea should be emphasized as the motive for acquiring knowledge. From another standpoint, the author does not believe in specialization for beginners. The child-mind is drawn toward Nature at first from all sides. To accord with this, study should be primarily broad rather than deep. It will be useful to note if this method results in preserving the youthful zest for knowledge. The book contains an index and suggestions for reading in connection with each subject.

In a paper on *Comparative Architecture*, Mr. *Barre Ferree* defines his subject as taking the facts of historical and descriptive architecture and describing the comparative progress made by all nations under all conditions. It does not concern itself with the history and descriptions of styles, but with the reasons for their existence. There is no greater evil in architectural study than isolation. No just estimate of all the works of men can be possible which does not take into account their buildings; yet architectural historians do not hesitate to prepare essays on these subjects in which the historical events that rendered possible the great structures they are describing are ignored or scarcely referred to. "As complete a record is needed for understanding the life of a building as for understanding the life of a man." Such are some of the features which the author regards as essential to an adequate treatment of the subject.

The *Report for 1891 of the Chief of the Weather Bureau* refers more particularly to the scientific and practical work of the office, and enlarges upon some of the features of especial interest to the public. The chief of the bureau has endeavored to extend the benefits of the meteorological service to agricultural interests, as they had already been applied to commercial requirements. The attempt to enlist in the work scientific men of established reputation not regularly connected with the bureau has been fairly successful. In their reports especial attention will be paid to the applications of meteorology to agriculture.

A very useful number of the Experiment Station Bulletins of the Department of Agriculture is that which consists of a paper on *The Fermentations of Milk*, by *H. W. Conn*, of Wesleyan University. The paper contains a summary of our present knowledge regarding the decomposition changes in milk under the influence of ferment changes and bacteria, with particular reference to the needs of the dairy industry. Among the special topics discussed are fermentation by rennet, souring, the number of bacteria in milk. relation of electricity to souring, alkaline fermentation, butyric acid, bitter milk, alkaline curdling and the peptonizing process, blue milk, alcoholic fermentation, slimy fermentation, miscellaneous fermentations, and the practical bearing of the subject upon dairying in its several branches.

The Seventh Annual Report of the Board of Health of the State of Maine is largely devoted to school hygiene, and embodies what might be called considerable treatises on the healthfulness of schoolhouses, school diseases and infectious diseases, the personal hygiene of the pupil, the hygiene of instruction, physical culture, the schoolroom, desks and seats, ventilation, heating, water-closets, etc., and schoolhouse plans. An act to provide for the registration of vital statistics went into effect in the beginning of 1892, some of the fruits of which may be looked for in future reports. *A. G. Young*, M. D., secretary, Augusta.

A feature in the movement to secure the systematic construction of better roads, which is now pushed with vigor all over the land, is *A Memorial to Congress on the Subject of a Comprehensive Exhibit of Roads, their Construction and Maintenance, at the World's Columbian Exposition*, with an open letter to the President of the United States, in which *Albert A. Pope* is the chief promoter. The memorial is re-enforced by a large volume of expressions of personal and newspaper opinions.

Contributions from the Botanical Laboratory of the University of Pennsylvania, Vol. I, No. 1, contains papers on *Rudbeckia hirta* (a monstrous specimen), by J. T. Rothrock;

Dionæa muscipula (Ellis), by J. M. MacFarlane; An Abnormal Development of Inflorescence of *Dionæa*, by John W. Harshberger; Mangrove Tannin, by H. Trimble; *Epigæa repens*, by W. P. Wilson; A Nascent Variety of *Brunella vulgaris*, by J. T. Rothrock; and Movements of the Leaves of *Melilotus alba* and other Plants, by W. P. Wilson.

The History of the Higher Education in Ohio is published by the United States Bureau of Education as a number of Herbert B. Adams's series of contributions to American educational history. The preparation of the work was undertaken by Prof. *George W. Knight*, and, he falling ill, has been continued and completed by Mr. *John R. Commons*. The history of college education in Ohio is of peculiar interest, on account of the relatively large number of colleges that have been organized within the State, and the variety of the experiments that have been tried in connection with them. The success and failure alike of these institutions afford lessons valuable to men interested in education.

The *Lake Magazine* is a new monthly periodical, devoted to politics, science, and general literature, published at Toronto, Ont., and intended to represent Canadian thought, discuss Canadian questions, and promote Canadian interests. The first number contains articles on Canada and Imperial Federation, The Franchise, A Canadian Literature, Art in Canada, etc. For succeeding numbers, articles are promised from leading politicians, divines, and literary men, on topics of current interest.

The report of the *Public Industrial and Art School*, Philadelphia, gives an account of the objects of the school, its methods, rules, regulations, and course of instruction. The directors claim that this school was the first practical and successful attempt ever made in Philadelphia or elsewhere to incorporate manual training as an integral branch of common-school education. It was started in 1880, largely through the efforts of Mr. Charles G. Leland. It has grown rapidly, and its facilities have been enlarged till now nearly seventeen hundred pupils, from every grade of the public schools and the teachers' classes, are taught in it weekly.

A Sketch of the Life of Joseph Leidy, prepared by Dr. *W. S. W. Ruschenberger* for the American Philosophical Society, is published by MacAlla & Co., Philadelphia. It contains in an appendix a list of Dr. Leidy's publications, society papers, and verbal reports to scientific societies, occupying twenty closely printed pages, together with a list of learned societies at home and abroad of which he was a member.

The *National Popular Review* is a new illustrated journal of preventive medicine and applied sociology, edited by *P. C. Remondino*, M. D., and published by J. Harrison White, at San Diego, California. It proposes in all matters to occupy a middle ground whereon the profession and the laity may meet to discuss matters of common interest.

Department M of the World's Columbian Exposition, Chicago, includes the branches of *Ethnology*, *Archæology*, *History*, *Cartography*, *Latin-American Bureau*, *Collective and Isolated Exhibits*. It will have forty acres of floor space in the building, and a strip of land nearly a thousand feet long in addition. The plan and classification of the exhibit are published in detail by Prof. F. W. Putnam, chief of department, and provide for a very full showing, particularly in the North American and Latin-American departments.

Of the fifth volume of the *Journal of the College of Science, Imperial University, Japan*, Part I contains Studies on Reproductive Elements; on the Formation of the Germinal Layers in *Chelonia*; on the Development of *Limulus longispius*; on the Lateral Eyes of the Spider; on a Collection of Birds from Tsushima; and on the Formation of Germinal Layers in *Petromyzon*—all by Japanese authors. Part II is mainly devoted to a Study of the Disturbance of Isomagnetics attending the Mino-Owari Earthquake of 1891, by Profs. A. Tanakadate and H. Nagaoka, with an Optical Note by K. Takizawa.

We have received Part III of Vol. I of *Iconographia Floræ Japonicæ*—descriptions, with figures, of plants indigenous to Japan, which has been prepared by Mr. Ryōkichi Yatabe, and is published in Tokio. Plants belonging to seventeen orders are described and illustrated, with Japanese and English text and full-page engravings.

A lecture on *The Discovery of America by Christopher Columbus*, which was delivered before the Young Men's Hebrew Association, in Wilkesbarre, Pa., in December,

1891, by Mr. *Harry Hakes*, has been published in a convenient pamphlet for the reading of that large class who, "in this hurrying age, will neither purchase, peruse, nor possess the extensive literature pertaining to the discovery of America." It presents a clear and fully adequate statement in brief of the work of Columbus, and of his right to be regarded as the real discoverer of America, of which the author is a strenuous upholder.

A paper on *Michigan Flora*, prepared for the Thirtieth Annual Report of the Secretary of the Michigan State Board of Agriculture, by *W. J. Beal* and *C. F. Wheeler*, has in it an element of surprise. Expecting to find it a formal botanical catalogue, we find instead a series of brief sketches, appealing at once to readers who are of the people, on various aspects of the vegetation of the State. First is an account of the topography of the State and the botanical regions, with lists of the characteristic plants; then a comparison of the trees and shrubs of Michigan with those of the rest of the world, the reason explained why Michigan has so many trees and Great Britain so few, Planting the Roadside and about the Home, Planting a Wild Garden, plants of various habits suitable for cultivation, The Procession of Flowers, timber plants, forage plants, weeds, and so on, till finally, after all the plants have been told about, the formal catalogue is given.

Mr. *John Luchsinger* contributed to the eighth volume of the Wisconsin Historical Collections a sketch of the Swiss colony of New Glarus, Wis., which attracted much attention, it being the first monograph on the planting of an organized foreign colony in the State. Since that time, thirteen years ago, a healthy popular interest has been awakened in the history of the several foreign groups of the State, and a renewed call has been made for the Luchsinger paper. The account has accordingly been rewritten by the author, who came over a child with the first settlers, and has been prominent in the life of the colony. The present paper, *The Planting of the Swiss Colony at New Glarus*, Wis., greatly enriched by additional documentary material and brought down to date, is practically a new monograph, drawn from original sources, and of great interest to all students of our composite nationality.

In a paper on *The Relation of Philosophy to Psychology and to Physiology*, Prof. *Joseph Le Conte* uses the term philosophy as meaning the science which treats of the activities of free, self-conscious spirit. The various forces, physical or psychical, are regarded as operating on separate planes without gradations, changeable from one form to another, and always related by mutual dependence. As the physical underlies and conditions chemical phenomena; the chemical, life phenomena; and the vital forces, psychical phenomena; and as the accomplished chemist must understand physics, the physiologist chemistry, and the psychologist physiology, so also psychical forces underlie and condition the phenomena of free spirit, and therefore the philosopher must understand psychology.

In another paper, on *Plato's Doctrine of the Soul, and Argument for Immortality, in Comparison with the Doctrine and Argument derived from the Study of Nature*, Prof. Le Conte presents the evolution doctrine of spirit—that the only significance of the whole history of the evolution of the cosmos through infinite time is, that it is a gestative process for the birth of spirit; and, with this, a corresponding theory of knowledge and method of extending its domain, and a philosophy of right conduct of life, or a theory of *spirit culture*—a philosophy equally removed from the ascetic on the one hand and from the hedonistic on the other.

The third part of Volume IX of the *Journal of the Academy of Natural Sciences of Philadelphia* contains a Memoir on the Genus *Palæosyops* Leidy and its Allies, by Charles Earle, and a paper on the Fossil Avifauna of the Equus Beds of the Oregon Desert, by Dr. R. W. Shufeldt. Palæosyops is a fossil of the Bridger Eocene, of an animal that was more like the tapir than any other living animal, of which a considerable collection of material exists in the Museum of the Philadelphia Academy and a larger collection at Princeton, the two collections being ample enough to permit a satisfactory conjectural restoration. Dr. Shufeldt's studies of fossil birds are based upon the collections of Prof. Thomas Caydon, of Eugene City, Ore., and Prof. Cope, of specimens from Fossil and Silver Lakes. In the view of the author, they establish the fact that the birds of the later Tertiary time were sim-

ply the direct ancestors of existing genera and species of birds, from which, in the majority of instances, they hardly departed; and they suggest questions why certain types should have perished without leaving any apparent descendants, while others, seeming to enjoy no more favorable conditions, have been preserved.

The elaborate memoir of Profs. *W. K. Brooks* and *F. H. Herrick* on *The Embryology and Life History of the Macroura* is based upon the studies by Prof. Brooks of the larval stages of the order continued at every opportunity during ten years, in connection with the Marine Laboratory of Johns Hopkins University, and upon studies of the life histories of additional species made by himself at Beaufort, N. C., and Green Turtle Key and New Providence in the Bahamas, and (chiefly) by Prof. Herrick under his general supervision. Marine crustaceans are regarded by the author as of exceptional value for the study of the laws of larval development and for the analysis of secondary adaptations as distinguished from the influence of ancestry by reason of the greater stability of their inorganic environment as compared with that of land animals, permitting greater persistency of type; and of the more definite character of the changes that make up their life history. The memoir, of about forty quarto pages, is illustrated by fifty-seven large colored plates.

Stone and *Milling* are two monthly magazines the fields of which are indicated by their titles, published by the D. H. Ranck Publishing Company, Indianapolis, Ind. The tables of contents embrace a variety of information, technical, practical, and popular, on stone-quarrying and working the kinds of stone available in the arts, road-making, contracting, and building, in the former magazine; and the operations, industries, economies, financial interests, etc., connected with the art of preparing grain for food, in the latter.

A convenient epitome *Sketch of the Geology of Alabama* is published by *Eugene Allen Smith*, State Geologist, in which a general comprehensive survey of the formations is given in a small space. As appears from the table appended, the formations represented are the Archæan (crystalline schists), Cambrian, Silurian, Devonian, Carboniferous, Cretaceous, the three Tertiaries, the Pleistocene, and the Recent.

The Royal Road to Beauty, Health, and a Higher Development is described in a pamphlet of 85 pages, by *Carrica Le Favre*, as lying through a vegetarian life. The author has complete faith in her doctrine, writes forcibly, and, together with some assertion that is only opinion, presents some strong arguments. Published by the Fowler & Wells Company. Price, 25 cents.

The Government Printing Office has published, in 1892, the *Report of the United States Commissioner of Fish and Fisheries* for the year ending June 30, 1889, a pamphlet of 128 pages. The year was the first one of operations as a branch of the public service distinct from the Smithsonian Institution. The inquiry respecting food fishes and the fishing grounds was continued, with more attention to details than in preceding years, the first surveys being necessarily general in their character. The most important seacoast inquiries were those conducted by the steamer Albatross in the North Pacific Ocean. On the Atlantic coast the steamer Fish Hawk was assigned to special investigations having reference to the oyster grounds of Long Island Sound and Rhode Island. Other sea work was done in the Gulf of Mexico. An essentially novel feature of the scientific work was the systematic investigation of interior waters with respect to their physical and natural-history characteristics.

Physical Education is a monthly magazine devoted to physical culture, published by the Triangle Publishing Company, Springfield, Mass., *Luther Gulick*, M. D., and *James Naismith*, editors, of which specimen numbers have been sent us. It has among its contributors some of the best-known physical culturists in the country. Some of the articles in the numbers before us are on Ventilation in the Gymnasium, by R. A. Clark, M. D.; Physical Education in its Relation to the Mental and Spiritual Life of Women; Bicycling for Women; Form in Gymnastics, by Dr. W. G. Anderson; Gymnastic Classification, and others of like bearing.

The Report of *Robert T. Hill*, Assistant Geologist, *On the Occurrence of Artesian and other Underground Waters in Texas, Eastern New Mexico, and Indian Territory, West of*

the Ninety-seventh Meridian, relates to a region vast in extent—including more than three hundred thousand square miles, and embracing many diverse conditions that influence the water supply—and one that has been little studied by geographers and geologists. The regions discussed—for there are more than one of them—are radically different in most natural aspects from the older inhabited portion of the United States. "It is far more different from New England than is Japan. It has more points in common with Europe than with the great Mississippi Valley. The chalk lands and downs of Texas are more related to France than to the rocks of the adjacent Arkansas and Missouri States." The author has endeavored to give only the laws of the occurrence and distribution of water. First, he corrects some prevailing mistakes on the subject, and shows how water really gets under the ground and is found there; then he describes the several regions topographically and geologically, and with reference to the conditions as to underground waters. This part of the work is well illustrated by maps and sections.

The *Industrial Magazine* is a new periodical devoted to the Promotion of Legitimate Industrial Enterprises, Railroad and Manufacturing Interests, and General Topics; Mrs. *Kittie F. Miller*, editor; published by the Industrial Magazine Company, Chicago. In the first two numbers railroad matters are given prominence and occupy by far the largest proportion of the space. Other enterprises are noticed in special articles; and information of what is going on in the railroad and industrial world is given in brief items.

PUBLICATIONS RECEIVED.

Adams, Charles J. Where is my Dog? or, is Man alone Immortal? New York: Fowler & Wells Co. Pp. 202. $1.

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POPULAR MISCELLANY.

The Indo-European Conception of the Soul.—In a paper in the British Association on The Indo-Europeans' Conception of a Future Life and its Bearing upon their Religions, Prof. G. Hartwell Jones said that three heads naturally suggested themselves: 1. The connection of body and soul. 2. The condition of the deceased. 3. The relations between the departed and those left behind. With regard to the nature of the soul, he pointed out that in primitive times souls were ascribed to the universe—the *anima mundi*—to nymphs of various kinds, to the lower animals, to fountains, or trees. Heaven was the source from which the soul of man was derived, and to which it returned after purification. As to its creation, it had no corporeal element; it was created before the body; sometimes it was identified with fire. The etymology of the expressions for soul were instructive—e. g., Sanskrit *atindriya*, or "transcending the senses"; Greek θυμός, from a root meaning to shake, or fan; so, too, the notion of "air," "vapor," "shade." Still more common was the idea of "breath." Its seat was the heart or blood. At the moment of dissolution the soul escaped through the mouth or nostrils; it left with a groan, it passed to the ethereal regions. Death was often looked upon as a kind of sleep. Their stoicism in the face of death was attested by the frequency of suicide, or of substitution, or the prohibition of mourning. The theory of a future life prevalent in the animistic stage was that of continuance, the tastes and occupations being the same as in this world; even Homer had not overgrown this. But this existence was incomplete and dreary; the ghosts gibbered and were doomed to silence. The severance was not complete, for the welfare of the spirit depended upon the proper treatment of the body, else it wandered disconsolate. Hence the observance of rites. At first the body was disposed of by inhumation, probably to preserve the iden-

tity of the deceased; but in certain conditions of life, as during war or the chase, cremation was employed. At least a handful of dust had to be sprinkled over the corpse before the spirit could obtain repose; its neglect was regarded with horror. The same motive dictated the rearing of cenotaphs. The tomb was constructed on the model of the house. The deceased was furnished with all the necessaries for his new home—attendants and wives, dogs and horses, weapons, clothing, and earthenware. As to the abode of the dead, the earliest theory was that the soul became ethereal, passing into the wind, or fire, or constellations. The exact locality was uncertain, because of the nebulous character of their life, for they followed certain Great Spirits. Then the region of bliss was placed in the west. The germs of a theory of recompense and punishment were found early. No doubt the idea gained in clearness when they came into contact with the Semites. Transmigration, regeneration, and purification belonged to a later time. The relation between the living and the departed was a wide question. In addition to the care taken at burial, there was constant communication—e. g., in dreams. Hence the respect shown to (1) kindly spirits, like the *pitaras*, *fravashi*, *manes*, etc.—the givers of wealth; (2) the evil-disposed, like the *lemures* or *larvæ*. This gave rise to ancestral worship, and was connected with the sustentation of the family; children were buried under the eaves of houses, and did not need propitiation. Thus the worshipers were actuated by fear and sympathy.

Cultivation of Sunflowers.—The history of the cultivation of the sunflower in Russia is easily written, for it was begun in 1842 by one Bokareff, at Voronezh, for the purpose of making oil from the seed. It has now extended to the adjacent provinces in the Volga basin, so that the acreage in sunflowers increased from 367,800 acres in 1881 to 704,500 acres in 1887. Sunflowers with small seeds are cultivated for the oil, and those with large seeds for eating the seeds as nuts. The oil is extremely nutritious, and has a pleasant flavor. Another source of profit is found in the residual cake, for which there is a constant and growing demand abroad. The shells or husks of the seeds also form a valuable article of trade as fuel, when wood is scarce; and the seed "cups" are prized by farmers as food for sheep. The money value per acre of the crop is large, perhaps superior to that of any other crop cultivated in Russia. The methods of cultivation are various. Some of the Russian farmers invariably sow sunflowers after wheat or rye, and others only after oats. Others advocate sowing after clover, and some consider it most profitable to put sunflowers into land which, after four or five crops, has lain fallow for two years. On the other hand, it seems generally admitted to be a mistake to sow grains immediately after a sunflower crop, an interval of a year being necessary to rest the land. Some of the farmers of Voronezh sow sunflowers in the same field for seven years in succession; then sow buckwheat; and then, after a year's rest, rye. As firewood, the stalks of the sunflower plants produce a bright, hot flame quickly, and form a pleasant and fragrant fire. An acre of sunflowers will yield about a ton of this fuel. As the sunflower is rich in potassium, even the ashes have a commercial value for fertilizing purposes.

Respect for Books.—The London Spectator remarks upon the respect which the average Briton has for libraries in themselves, no matter how little he reads or how averse he may be to spending money for books, as one of the most inexplicable features of his character. "The impressiveness of a library," it says, "is felt by classes far outside the one which passes its life in using books. The ordinary population of an ordinary town, though it will not always vote the cost of a free library, is proud to believe that the town library is a good one, regards its increase as something to be recorded with triumph, and enters the rooms in which it is kept with a kind of awe. It is considered a mark of caste to possess a good library, and a house will sell better because there is a room in it which has been devoted to the keeping of books, and that to men who would regard a day spent among books . . . as intolerably tedious." The feeling is said to extend to those who can not read, "and it is undoubtedly true that servants, though they will neglect a library to any extent, and apparently believe that dust on book-shelves

is matter in the right place, will take any trouble not to injure books if they are accumulated in any numbers. . . . We suppose the true reason is that, as all men respect knowledge, and especially knowledge of which they only dimly perceive the use, they regard a library as a deposit of bottled wisdom, by which they can hardly profit, indeed, but which they had rather not injure or disperse." There are evidences that the same feeling of respect for books as books has influence also with cultivated people.

A Hopi (Indian) Baby.—After a child is born to a Hopi Indian (says Mr. J. G. Owens, in an article in the American Journal of Ethnology and Archæology) the mother bathes her head in a suds made of the amole root, and an attendant bathes the baby in a suds of the same, and rubs it, except its head, in ashes, these being supposed to kill the hair on the body. The baby is then put in a cradle, and an ear of corn is placed by its side to watch it. The regular Hopi cradle consists of a wicker base, woven of small twigs of *Rhus trilobata*, about two and a half feet long and a foot wide. Six or eight inches from one end, the head, is a bow of the same material, about two inches wide and nine inches high in the center. This is to keep anything thrown over the cradle from falling on the face of the baby. Covering three quarters of the base is a mat of cedar bark. Several small blankets are laid across the cradle and the little one is placed upon them, with its head generally lower than the rest of the body. The arms are laid straight by its side, and the blankets are folded over and kept in place by lacing a heavy woolen cord with loops of the same material on either side of the cradle. Frequently the presence of a baby in a house would be entirely unsuspected; but should you attempt to sit upon what appears to be a pile of blankets in a corner, the protests of the watchful mother will at once admonish you of your mistake. Until the fifth day the mother must not see the sun or put on her moccasins. On the morning of that day she bathes her own head and that of the baby with amole, puts on her moccasins, and is then at liberty to go out of the house. She resumes charge of the household affairs, and by the tenth or twelfth day seems to have regained her normal strength. Sometimes a mental record of the age of the baby is kept, with the aid of the fingers; in other cases scratches are made by the thumb-nail on the wall. On the tenth and fifteenth days, respectively, the mother again washes her head with amole, and bathes and rubs the baby with ashes, just as on the first day. On the twentieth day the chief ceremony takes place, which includes the purification of the mother, the naming of the baby, and the presentation of the baby to the sun. These are described in detail in Mr. Owens's article.

The Crustacean's Shell.—No group of animals, says Prof. W. K. Brooks, is more favorable than the Crustacea for the study of the significance and origin of larval forms, for these animals possess a number of peculiarities which serve to render the problem of their life history both interesting and significant, and at the same time unusually intelligible; nor are these peculiar features exhibited in the same degree by any other great group of animals. The body of the arthropod is completely covered, down to the tip of each microscopic hair, by a continuous shell of excreted matter, and as this chitinous shell is not cellular, it can not grow by the interpolation of new cells, nor can it, like the excreted shell of a mollusk, grow by the deposition of new matter around its edges, for there are no such edges, except in a few exceptional cases, such as the barnacles. Once formed and hardened, the cuticle of an arthropod admits no increase in size, and as soon as it is outgrown it must be discarded and replaced by a new and larger one. The new shell is gradually excreted, in a soft condition, under the old one, and as soon as this is thrown off the new one quickly becomes distended and solid. As a result, from the very nature of the chitinous shell and the method of renewal which its structure entails, the growth of an arthropod, from infancy to an adult condition, takes place by a series of well-marked steps or stages, each one characterized by the formation of a new cuticle and by a sudden increase in size. In most arthropods the newly born young are very different in structure from the adults, and growth is accompanied by metamorphosis. As the changes of structure are neces-

sarily confined to the molting periods, the stages of growth coincide with the stages of change in organization, and there is none of the indefiniteness which often characterizes the different larval stages of animals with a more continuous metomorphosis. On the contrary, the nature of each change is as sharply defined and as characteristic as the structure of the adult itself. As the molting period is frequently a time of inactivity, the animal may then undergo profound changes without inconvenience, and the successive steps in the metamorphosis of an arthropod are not only well marked but often very profound as well.

The Bantu.—More than thirty-five years have elapsed since the term *Bantu* has been applied to a large and widespread family of African languages; but it is little known except to specialists. There is no Bantu country, no nation of that name; the word has become an ethnographical but hardly a geographical expression. And yet, after a little explanation, says The Athenæum, it will be found so pregnant of meaning, so expressive of the hundred and more languages to which it applies, that it is not likely ever to be superseded. *Bantu* is the plural of *mu-ntu*, the general term for a human being common, with hardly any modification, to the languages spoken throughout South Africa, "from the Keiskamma River to the equator on the east, and from Walfish Bay to the Old Kalabar River on the fifth parallel of north latitude in the west"—that is, to the whole of the southern half of that vast continent, with the sole exception of the territories occupied by the Hottentot and Bushman tribes. The term *Bantu*, it should be added, is mainly used by the natives when speaking of themselves in contradistinction to white people. One of the various characteristics of these languages is to mark the grammatical categories almost exclusively by prefixes; and another to regulate the building up of sentences by certain laws of alliteration, the so-called "concords." It is, moreover, a remarkable fact that there is common to all these languages a great resemblance, not only of grammatical forms, but also of words, and, to a certain extent, of idioms, so that it is in some cases difficult to decide whether any two languages, though separated by wide tracts of country, do not actually stand in the relation of mere dialects. Indeed, as to closeness of kinship, the Bantu languages can far more fitly be compared to the Neo-Latin or Slavonic than to the Indo-European languages. There are on the northwestern confines of the Bantu field, and beyond, a number of languages somewhat akin to the Bantu, to which Mr. Torrend, in his Comparative Grammar of the South African Bantu Languages, assigns the name of semi-Bantu. They stand in the same relation to the Bantu as the Melanesian languages do to the Malayo-Polynesian.

Intemperance in Cycling.—Noticing some recent extraordinary achievements in cycling—such as the conveyance of a dispatch from Chicago to New York in one hundred and eight hours and the covering of four hundred and thirteen miles in twenty-four hours—The Lancet inquires into the cost of such exploits, and answers: "The cost to the rider is, we say at once, altogether unwarrantable, for during the twenty-four hours in which a rider is occupied in covering four hundred miles his heart knows no rest from full activity, and the elastic coat of every artery in his body is in full tension. In some instances such is the tension that the man literally propels himself in what may be called blindness. His legs work automatically and his course is directed in a manner very little different. When a bicyclist was unfortunately killed from an accident caused by fast riding, a witness said, on oath, that the rider was going so fast and was so intent on the race he did not hear witness until it was too late, that is to say, until he got within two yards of a cart into which he ran, when he altered his whole position, called out 'Oh!' and coming into collision received the fatal injury. In another instance, where one of the long and sleepless rides was carried out, the rider was seized with vomiting, which never ceased during the whole of the effort. He, too, lost the guiding power of his senses, and for some miles tugged on as if he were blind, tearing away, in fact, in a kind of trance, his higher nervous centers paralyzed and his body retaining its life and mere animal power, held living by the respiratory center and the heart, they also being taxed to the very extremity of danger." Young men may occasionally do

such things for once, without apparent immediate damage, but it is with great peril to their future vigor.

Famous Automatons.—Many ingeniously constructed automatons are mentioned in history or the fiction that goes with it. Among them are a wooden dove that was made B. C. 400; a fly presented to Charles V which went round in a circle and returned to its starting point; a bronze fly made by a bishop of Naples in the eleventh century which kept real flies out of the city; an eagle that flew before the Emperor Maximilian; and the brazen men that were made by Roger Bacon, or, according to others, by Albertus Magnus or Reysolius. A spider of the ordinary size was exhibited in London in 1810, which was caused by wheelwork to walk on a plate, and to shake its paws when taken hold of. A swan was on view about the same time, swimming in a basin of water along with some fish. It would seize a fish, swallow it, and then shake its wings. A few years afterward a gold bird appeared, which would come out of a tobacco box, spread its wings, and sing. The famous automaton chess-player was a humbug. It was not moved by machinery, but by a man hidden inside. Some very curious automatons were constructed by Vaucanson in the eighteenth century. Among them were a flute-player which played a dozen airs, and another performer which played twenty different tunes with a tambourine and a flageolet. These "artists" were worked by a strong spring that acted on numerous whistles supplied with air from reservoirs which were opened at the proper times. Vaucanson also made an asp for Marmontel's Cleopatra theatre, which could coil itself, thrust out its tongue, and hiss. His duck was a very famous imitation; for it could move its head around in search of food, swallow, and "digest." The secret of its "digesting" was discovered by Robert Houdin when he was engaged in repairing it. The food that was given it was removed during the intervals between the exhibitions and suitable "digested" matter, or the imitation of it, supplied. Houdin was very ingenious and was employed to repair other complicated machines. Among them was a mechanical organ that could improvise variations, that had been taken to pieces without marking where the several parts belonged. He succeeded in putting it together again, but it is not known what eventually became of it. The visitors to a certain seminary in the old times were met at the door by an automatic skeleton which welcomed them by clapping its fleshless finger-bones.

Periodical Variations of Glaciers.—The question of the periodicity of changes in the glaciers of the Alps is hereafter to be studied systematically. It has been taken up by the Council of the Canton of Le Valais, which has put the matter in charge of the administration of forests. A report made by M. Forel to the head of the Home Department represents that glaciers in general, and particularly those of Le Valais, are subject to variations in shape, which, according to an irregular periodicity, cause them sometimes to grow in length, in breadth, and in thickness, and sometimes to decrease, often in very considerable proportions. It has been recognized that most of the great catastrophes which have ravaged the region of the high Alps have been caused by these glacial variations. It is when the glacier extends, lengthens, and arrives at its maximum, that it invades the fields and destroys Alpine chalets, barricades the valleys, arrests the flow of rivers, and creates temporary lakes, the evacuation of which devastates the country; or else, surpassing its usual dimensions, it forms an avalanche, the destructive power of which is terrible. The preparatory study of these variations that has been made in the last few years has shown that their periodicity is much longer than was formerly believed to be the case; the popular dictum that the increase in size of glaciers recurs every seven years is certainly incorrect. Definite figures can not yet be given, but probably the cycle of glacial variation is as much as from thirty-five to fifty years. If 1850 or 1855 be fixed upon as the epoch of maximum, they have been steadily decreasing in past years, so that from 1870 to 1875 not a single glacier was known to be on the increase. Since then an increase appears to have begun in the glaciers of the Mont Blanc group, but most of the others are still retreating or stationary. Hence the phenomenon is one of which a man in an ordinary lifetime can see only a single mani-

festation; and it is therefore impossible for one man to make an adequate study of it. This is the ground on which M. Forel asked the state to take charge of the matter.

A Remarkable Fig Tree.—Fig trees grow in Brittany, usually in sheltered places, where they are rarely much taller than the structures that protect them. Near Roscoff is a tree of unusual size and which is very famous. It is about the same height as the other trees of the region—say twelve or sixteen feet—but covers with its branches a surface which may be estimated at about four hundred square metres. It is situated in a farm garden. Its single low, gnarled trunk is partly inclosed in a broad wall, so that it is difficult to measure its diameter exactly, but it is in the neighborhood of twenty inches. From it, starting at about six feet from the ground, a great many limbs extend horizontally in all directions—some of them as far as fifty feet. These limbs are supported on two garden walls and on thirty-eight granite posts, between two of the rows of which is a covered alley-way, about eighty feet long. A French writer, M. A. Mehard, says that when he saw this tree for the first time, in September, 1884, it was covered with a thick, green foliage, and had on it a great many figs, some of which were beginning to ripen. He asked how old it was, and was told that the oldest persons in the region had never known it to be different from its present appearance. "How many figs a year does it bear?" "As many as we want; if we pick them every day, there are always some left." "But how many do you pick a day?" "Several baskets a season" (of two or three months). "Is it still growing." "Yes, sir; it would soon cover the whole plot if I didn't cut off the ends of the limbs every year." It is true that the tree, though very old, is still vigorous and bears good fruit; and that, notwithstanding the disproportion between the trunk and branches, the latter make good growths. The tree stands at the extreme limit of vegetation approaching the seashore.

Botany as a University-extension Study.—Writing in University Extension in favor of placing botany among the subjects of extension lectures, Prof. J. M. McFarlane remarks upon the extent to which the mind has been blinded by the current system of education to the perception of all that is in the living world outside it. One, he says, "can watch the process going on. Every average child shows a natural desire to become acquainted not only with the men, women, and children that he meets day by day, but with the animals and plants that he sees moving and growing. This tendency is usually encouraged by the parents if they are sensible and know something of the facts of Nature. In the majority of cases, however, through pure ignorance they stifle the budding qualities of the child. And as school education advances, the stifling process is completed, for the child is silently taught that all knowledge can only come from books or the talk of teachers, and that to acquire knowledge through the tongue, by touch, from the sounds of natural objects, or by an eye-to-eye study of them, is a waste of time." Perceiving that the course of a few extension lectures is not sufficient to ground pupils well in Nature studies, the author suggests the combination with it of correspondence teaching. In proof of the feasibility of this, he shows that he has himself for eight years directed the work of students hundreds of miles apart, some of whom were advanced to the study of the highest works on the subject. But, besides the use of books and hand diagrams, he every fortnight forwarded from ten to thirty fresh specimens to each, which they were required to examine, describe, and classify. Material for microscopic study was supplied for those possessed of suitable instruments. Many of these pupils are now successful teachers of biology in schools and colleges, and two of them have established school botanic gardens.

Pepper-raising in Cambodia.—The pepper plant, says M. Adhémard Leclère, in the Revue Scientifique, is not a bush, as some writers say, but a vine which has to be supported by a tree when wild and by a strong stake when cultivated. The author has seen the vines growing nearly wild near Chandoc in Cambodia, where they had been planted by the villagers and left to themselves. They grew vigorously and to considerable length, but bore only a few bunches of fruit and that of an inferior quality. An abundant crop of good pepper can be obtained only by careful and

skillful cultivation. The industry thrives in the province of Kampot, where it is pursued in some twenty villages. At the village of Suam Ampil there are eighty-nine planters and more than a hundred plantations, containing 48,441 stocks. The plants are propagated from cuttings, which are made about eighteen inches long and are taken from stocks two or three years old; they are supported by stakes about ten feet high, which are solidly planted in the ground; and are fertilized at the same season every year with a special manure which is composed of eight parts of good soil and one part of pounded shrimp shells. The plants are liable to attack by a minute parasite that destroys their fruitfulness, to obviate which they are treated with a decoction of tobacco. The first crop, but an insignificant one, appears in the third year from planting. A crop of about a kilogramme per stake of two plants is gathered in the fourth year, and the increase continues for eight or ten years. Exceptional plants in good soil may return four kilogrammes per stake; but a crop of from two to two kilogrammes and a half is considered a fair average. Some plants will live fifty years, but they are seldom remunerative after forty years; and, as a rule, a plant thirty-five years old is considered of no further value. The plants bloom in May and June, and the gathering of the crop begins in February. The bunches which have turned red are picked, and the others are left for future visitations. The berries are stripped from the bunches and dried in the sun till they are black, when they are packed and made ready for sale. White or gray pepper is produced by letting the berries get a little riper, and cleansing them from their outside envelopes. In some districts the removal is assisted by soaking the berries in sea-water. One laborer can usually take care of about one thousand stakes.

Yaks, Wild and Domestic.—Immense herds of wild yaks still pasture on the steppes in the region of the Lob Nor and Thibet. Individual species have been domesticated and are as cows and oxen to the people of the country. Thick and strong cloths are made from their hair; the tufts of their tails are used in standards; their meat is juicy, and their milk is not inferior to that of our domestic cows; and they are highly valued by the Thibetans as draught and pack animals, and even for riding, on account of their hardiness, readiness, and sure-footedness. Attempts have been made to domesticate them in France, but the climate proved not suitable to them. Comparison of the skins of domestic yaks with those of wild ones shows how the animal has been modified under human influence and through changes in its medium. The hide of the domestic yak has become fine, is often silver-white, or gray varied with white; and the horns, when they have not disappeared, form a simple curve outward and upward; while in the wild yak the hide is uniformly black or very lightly shaded with brown, and the horns, which are nearly three feet long, describe an incomplete S, starting outward, then growing forward and then upward. Judging from the specimens presented to the Paris Museum by the Prince of Orleans, the wild yaks are much larger than the domestic animals, and the long hair on their flanks and legs grows lower down. Like the buffalo, these animals are dangerous to hunt, unless they are killed at the first shot.

Color Phenomena on Mars.—Prof. W. H. Pickering writes to the Journal of Astronomy and Astro-Physics concerning his observations of Mars at Arequipa, Peru: "The sudden changes of color exhibited by some of the smaller areas upon the planet Mars are sometimes almost startling. A recent view was obtained shortly before sunrise, when the snowy region about the south pole appeared of a most brilliant green, quite equaling in color the rather narrow green band situated just to the north of it. Later, as the sun came up, the color of the snow changed to a bright yellow, the rest of the disc changing in the mean time to orange. Later the seeing improved, several of the canals became visible, and the snow became as colorless as upon our surrounding mountains. The two former effects were probably due to bad seeing, the fluctuations of our own atmosphere superporing the colors of the surrounding regions upon the snow. We have laid it down as a rule never to rely greatly upon our color observations unless the snow-caps of the planet appear perfectly colorless and the canal system is well defined." A curious feature of

the observations described by Prof. Pickering is an actual change of color which, eliminating all probable sources of error, the planet really seems to undergo. He believes that some time in the future these changes will be understood and their laws determined. He thinks the greatest danger lies from optical illusion.

NOTES.

A CORRESPONDENT of the London Spectator, Violet Davies, tells the following story of "a canine member of the Society for the Prevention of Cruelty to Animals": "Last week a sick dog took up its abode in the field behind our house, and, after seeing the poor thing lying there for some time, I took it food and milk and water. The next day it was still there, and when I was going out to feed it, I saw that a small pug was running about it, so I took a whip out with me to drive it away. The pug planted itself between me and the sick dog, and barked at me savagely, but at last I drove it away, and again gave food and milk and water to my *protégé*. The little pug watched me for a few moments, and as soon as he felt quite assured that my intentions toward the sick dog were friendly, it ran to me, wagging its tail, leaped up to my shoulder, and licked my face and hands, nor would it touch the water till the invalid had had all it wanted. I suppose that it was satisfied that its companion was in good hands, for it trotted happily away, and did not appear upon the scene again."

THE vermilion-spotted newt (*Diemyctylus viridescens*), as described by Simon H. Gage, has the curious property of changing from the aquatic to the terrestrial life and again to the aquatic, modifying or partially modifying its breathing organs to correspond with each change of medium. It appears that, after having lived on the land, the preparation for reproduction requires the terrestrial forms to enter the water, when the life becomes for a greater or less time once more partially aquatic, and that "the surroundings of larval" life and the necessity for respiration brought about by the prolonged stay under water required for fertilization and ovulation recall by a kind of organic memory the mode by which respiration was accomplished in larval life. The tree-toad and the yellow-spotted salamander are likewise capable of partially returning to an aquatic mode of respiration; and the siren, after having had its gills so far absorbed as to be mere stubs, returns to the water and reacquires them.

AN extraordinary grotto was recently revealed at Tavernay, France, by an explosion during the progress of the ordinary work in a quarry. This subterranean gallery, with walls polished as if by water, is about 1,500 feet long, and ends in a chamber about 40 feet in diameter and six feet high.

THE expedition sent in 1891 from Bowdoin College to Labrador has confirmed the truth of the reports that have been vaguely current for many years of the existence of a great cataract in Labrador. The stream forming the falls and rapids rises in the plateau known as "the Height of the Land." The spray of the falls was visible to the explorers when twenty miles away. The river, rushing through a gorge hardly more than 150 feet wide, makes a sheer plunge of 200 feet. Below the falls are rapids, which prolong the whole descent to quite 500 feet. The explorers sailed down the river for 300 miles below the falls.

AT the last anniversary meeting of the Royal Society the Copley medal was awarded to Prof. Rudolph Virchow for his services in natural history, morbid anatomy, histology, pathology, and ethnological and archæological science; the Rumford medal to Nils C. Dunér, of the University of Lund, Sweden, for his work in spectroscopic astronomy; Royal medals to Prof. Charles Pritchard, of Oxford, for photographic investigations in astronomy, and J. N. Langley for physiological researches; the Davy medal to Prof. François Marie Raoult for his researches on the freezing-point of solutions and on the vapor pressures of solutions; and the Darwin medal to Sir Joseph Dalton Hooker.

AMONG the Laos of the Siamese dominions, according to an article in the Kew Bulletin, tea leaves are not used for making an infusion as in other countries, but are prepared wholly for the purpose of chewing. They are steamed and then tied up in bundles and buried in the ground for about fifteen days. Leaves thus prepared, which are called *mieng*, are said to keep two years or more. The habit of chewing *mieng* is nearly universal among the Laos, and is said to be almost indispensable to men engaged in hard work.

EXPERIMENTS on the suitability of aluminum for horseshoes made in a Russian regiment of Finnish dragoons have resulted favorably. The horses were shod with three iron shoes and one aluminum shoe. When it was time to renew the shoeing, the shoes of aluminum were found to have worn as well as those of iron. None of them were broken, none showed any traces of rust. Among the advantages anticipated from the use of aluminum in horseshoes are greater facility in forging and a reduction of the load to be carried by the horse's feet.

THE American Microscopical Society has funds supplied it, from which it offers two prizes of fifty dollars each for the best papers giving results of original investiga-

tions relating to animal and to plant life respectively; two prizes of twenty-five dollars each for the second best papers on these subjects; a prize of thirty dollars for the best six photomicrographs on some subject in animal or vegetable histology; a prize of thirty dollars for the best collection of six mounted slides illustrating some biological subject; and two prizes of fifteen dollars each for the second best collections of photomicrographs and slides. The papers should be submitted to the committee on or before July 1, 1893 (W. H. Seaman, Secretary, Washington, D. C.). All photographs and slides for which prizes are given are to become the property of the society. The object of the prizes is to stimulate and encourage original investigation in the biology of North America.

DR. ALCOCK, of the Marine Survey of India, has observed in the structure in the nippers and arm of the red cycopod crab of the shores a regular fiddling apparatus like the stridulating apparatus of many insects. Its music is heard when the crab's burrow is threatened by an intruder, and gradually rises in loudness and shrillness and frequency if the presence of the intruder is continued, until it becomes a tumultuous low-pitched whirr or high-pitched growl, the burrow acting as a resonator. Crabs of the same species will not enter one another's burrows unless they are forced to, whence Dr. Alcock infers that the use of the stridulating apparatus is to warn others against crowding upon its hole.

MR. F. W. DOUGHTY, of Brooklyn, claims, in a pamphlet which he has published on the subject, to have discovered in the Glacial drift at different places in Massachusetts, Connecticut, New Jersey, and Pennsylvania, and on Staten Island and in the city of Brooklyn, evidences of man's work, testifying that the human race was old at the Glacial period. The evidences consist of representations of the human head cut in various kinds of stone or modeled in clay, flat tablets of clay bearing portraits of men and women and of existing and extinct animal forms, together with objects of primitive symbolism, such as occur on the most ancient coins, and clay molds and stone seals. His pamphlet contains a number of illustrations of these objects, which are curious, to say the least.

THE committee of the American Association to which the subject was referred, approve the resolutions of the Australasian Association concerning an international committee on biological nomenclature, advise that the French and Italian biologists be invited to appoint branch committees to act with the others, and make some suggestions respecting the underlying principles that should govern biological terminology. Thus the committee recommend that the names of organs and parts and the terms indicating position and direction should be single, designating words, so far as possible, rather than descriptive phrases; that morphological terms should be etymologically correct and derived from Greek or Latin, and each term should have a Latin form; that terms relating to position and direction in an organism should be *intrinsic* and not *extrinsic*—that is, should refer to the organism itself rather than to the external world; that in addition to its proper Latin form each of the technical words should have a form that shall make it conform to the genius of the various languages, or that a paronym be made for each technical word.

OBITUARY NOTES.

SIR RICHARD OWEN, one of the most famous comparative anatomists of the age, died in London, December 18, 1892, in the eighty-ninth year of his age. A full sketch of his life and work was published, with portrait, in The Popular Science Monthly, Vol. XXIII, No. 1 (May, 1883).

MR. W. MATTIEU WILLIAMS, author of the series of articles on The Chemistry of Cooking, published in the Monthly a few years ago, died suddenly at his home in Neasden, England, November 28, 1892. The book by which he was best known is The Fuel of the Sun. Much of his work was contributed to serial publications, and a volume of his popular essays was issued several years ago under the title of Science in Short Chapters. His Through Norway with a Knapsack called attention to the advantages of Norway as a summer resort for tourists.

DR. E. W. SIEMENS, a distinguished German engineer and electrician, died in Berlin, December 6, 1892. He was born at Leuthe, in Hanover, in 1816, taught in the Lubeck gymnasium, joined the Prussian artillery in 1837, and withdrew from the service of the Government in 1850 and devoted himself to scientific studies and private enterprises. He was the inventor of many of the most valuable practical applications of electricity and of devices in electrical apparatus, instituted the Siemens quicksilver unit, contributed much to the successful establishment of the electric railway, and devised the pneumatic dispatch system and the Siemens alcoholimeter.

PROF. JOHN S. NEWBERRY, of Columbia College, died in New Haven, Conn., December 7, 1892, after a long illness. He suffered an attack of paralysis in December, 1890, from which he never fully recovered, and which left him with a gradually failing mind. A sketch of his life and scientific work—chiefly in geology, in which he was one of the most eminent American experts—was given in The Popular Science Monthly, Vol. IX, No. 4, August, 1876. He received the Murchison medal from the Geological Society of London in 1888.